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BOSTON SOCIETY OF CIVIL ENGINEERSFOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

ADDRESS AT THE ANNUAL MEETING

BY FRANK M. GUNBY, PRESIDENT, BOSTON SOCIETY OF CIVIL ENGINEERS

(March 19, 1924.)

The Indictment and Suits Against Cantonment Constructors

THE Construction Industry was indicted by the Attorney-General's office of the executive branch of our government. That industry has now been exonerated of at least a part of the charges by the judicial branch of our government. The criminal indictment against several of that group of men, who visualized the construction program necessitated by the war and provided the solution for that problem, has been dismissed by Justice A. A. Hoehling of the Supreme Court of the District of Columbia.

The individuals who were indicted for conspiracy to defraud the United States in carrying out its war construction are:

Benedict Crowell, Former Assistant Secretary of War.
Colonel William A. Starrett, New York, Chairman of
the Committee on Emergency Construction and
Engineering.

Morton C. Tuttle, Boston.

Clemens W. Lundoff, Cleveland.

Clair Foster, New York.

John H. McGibbons, Chicago.

James A. Mears, Springfield.

It is the criminal indictment against these men which has been thrown out of court by Justice Hoehling's opinion sustaining the demurrer filed by the counsel for the defense, and claiming that the indictment did not establish a case worthy of being tried before the court.

The civil suits brought by the Attorney-General's office against the eleven contractors for cantonments are still pending.

There are three reasons which have caused me to decide that this case is of enough interest and importance to form the subject of your President's annual address.

(a) To do what we can to inform the public that these men, whose indictment was broadcasted throughout the land, have been exonerated; and to assure these men that we have always been steadfast in our belief in their integrity and honor.

(b) To remind us that there are still those eleven contractors who are being sued for \$55,000,000 whose cases are not yet tried, because their accusers cannot, or at least have not, made out a case against any one of them definite enough for trial to proceed.

(c) Because there is more on trial than these men and firms who were indicted and sued. There is more on trial than the construction industry. There is on trial the ability of the American people, and their institutions, to meet a great national emergency and to solve it by the use of the best men and methods available. If the people cannot call for and get the best that their ablest men have to give in times of great emergency, then we shall not survive many great emergencies.

INDICTMENT

The indictment against the so-called conspirators was procured in December, 1922. The indictment covers about 91 printed pages, and by innuendo accuses these men of about everything imaginable.

Boiled down, the charges seem to me to be about as follows:

(1) That the cost plus a limited fee contract was used, and that certain contractors were selected instead of others.

(2) That Secretary of War Baker (who is not indicted or criticized) should not, in the 1922 opinion of the Attorney-General's office, have adopted the policy he did in 1917, although that policy was provided for by law.

PROBLEM IN 1917

In the spring of 1917 this country was not prepared for war.

About May 1, 1917, there was formed in the War Industries Board the Committee on Emergency Construction and Engineering. One of the immediate problems this committee found to solve was that the Quartermaster Corps would be called upon to provide housing for 1,100,000 men by September 1, and that, with the organization available, there was not the slightest chance of getting this done.

It was known that the allies were in urgent need of aid and that that need was growing daily.

The Emergency Construction Committee in these early days of war consisted of W. A. Starrett, *Chairman*, M. C. Tuttle, C. W. Lundoff, Frederick Law Olmsted, Major William Kelley of the Corps of Engineers. Major Kelley was transferred overseas and was succeeded in June, 1917, by Mr. John Donlin, representing the American Federation of Labor.

Messrs. Leonard Metcalf and George W. Fuller were a sub-committee on engineering. The committee also had the advice of Mr. Howard L. Rogers and the assistance of Mr. James A. Mears and Mr. John H. McGibbons. Early in 1918, Mr. Tuttle left the committee to take up work with the Emergency Fleet Corporation. In March, 1918, Major Clair Foster became a member of the committee.

When the committee first met, its immediate job was to visualize the problem and take such steps as might be necessary for getting the work done. It must be remembered that the War Industries Board was not an executive organization. In the case of construction of army housing the actual work would be done by the Quartermaster Corps, which had always been charged by law with the responsibility of constructing housing for troops.

SOLUTION

The methods adopted for the solution of the problem consisted of —

- (1) Preparing a suitable form of contract.
- (2) Creating an organization to administer it.
- (3) Securing contractors to execute the work under it.

That the committee visualized the problem clearly and correctly is proved beyond question of reasonable men by the fact that the work — all the work — called for was completed on time, and time is the measure of efficiency in war work; and that at the end of the war, after two years of experience and two careful investigations, made by independent bodies as described later, the same principles of administration and the same form of contract were in use as at the beginning.

It having been decided that existing construction organizations should be used rather than waste time building new ones, the committee drafted a form of contract to be used in doing the work. The advice of engineers, contractors, architects, and construction men all over the country was sought and used in the preparation of this contract. It contains all the usual features and safeguards of contracts of its kind. The powers of the contracting officers are very broad in regard to protecting the government's rights, and the contract included provision for the government to abandon the work and terminate the contract at any time. Under this contract, the contractor was to be reimbursed for the cost of the work plus a fee based on a sliding scale, with a definite upset limit to the fee. The maximum limit of fee for the largest contract was \$250,000.

One of the honored members of this Society is, I believe, principally to be thanked for this idea of the upset fee. This contract form was used throughout the war by the Construction Division of the Army. In every contract there was the fixed limit to the fee. The Construction Division never let a contract without the upset limit to the fee, the size of the limit being dependent on the size of the job, but in any case not being higher than \$250,000. The much-repeated statement that the more

the cost the greater the contractor's profit is an unwarranted slander in the case of contracts under the Emergency Construction form.

This contract was used on over 500 projects, and it is a good one to live with from any standpoint.

The Committee on Emergency Construction having drafted a contract under which the work would be done, and gotten it approved by the War Industries Board, Colonel Littell's organization, and, finally, by the Secretary of War, proceeded to make recommendations of contractors capable of carrying out these stupendous jobs. These recommendations were passed on by the War Industries Board, then by the Cantonment Division, and finally approved by the Secretary of War. These first contractors were approved by Mr. Baker himself. The completion of the cantonments on time is the proof that the selections were good.

In taking up the work of selecting for approval contractors for the different jobs, the committee elected to take unto itself an onerous task, and one well calculated to bring to itself much criticism, and to insure great pressure from political and other sources. That it did assume this task is one of the large reasons for the success of the infant Cantonment Division. It may also be an explanation of some of the other events which followed later.

The war is over, and you have heard the tale before, so I shall not burden you with the story of the expanding of Colonel Littell's little group into the Cantonment Division, and later into the Construction Division of the Army, nor of the building of the cantonments, for which some of our friends have been indicted and some sued. The cantonments were built on time, served their purpose, and are now being cast aside, like the worn-out tools which they are.

I do want to tell you of one incident in regard to the cost of these cantonments.

The first real estimate for their cost was made about May 25, 1917, when enough studies and plans had been made so that some conception might be had of what a cantonment would be. The detail figures of cost of individual buildings and other items

on the typical plans had been carefully made. One night seven of us put all the figures together for the first time. The sum of these figures, including 15 per cent for contingencies, was \$97,500,000 for 16 cantonments.

Sixteen cantonments were built, and were about 75 per cent completed before the radical increases in requirements commenced. Adding to the cost of the work done the estimated cost to complete showed that it would have cost about \$105,000,000 to do what we first estimated at \$97,500,000. I submit that for those jobs to have been completed with an over-run of less than 10 per cent on the estimates does not sound as though the contractors were grossly inefficient. But they have been sued for \$55,000,000!

The final cost of the 16 cantonments was about \$143,000,000. The increase from the figures given above was for increased facilities and not over-run on original unit costs. For instance, the change to the requirements for the Pershing Division alone added over \$22,000,000.

AFTER THE WAR

The country, having done its bit toward helping win the war, went back to its business — and the politicians to theirs. Investigations were in order.

The Republican Congress appointed the Graham Committee to investigate war expenditures. A subcommittee to investigate cantonment construction was composed of Congressmen McKenzie and McCulloch, Republicans, and Doremus, Democrat. This subcommittee employed William T. Chantland of Iowa as counsel. This committee took about 3,000 pages of testimony, none of which was from men who had had responsible charge in a part of carrying on one of those jobs. The report of the committee was divided on strictly party lines, making a Republican majority report and Democratic minority report.

The majority report found the cost of construction excessive, based on an estimate made of the cost of one camp by J. P. O'Connor, an Illinois contractor, who had not built any camps. It found the excess cost for 16 cantonments was \$78,531,521!

The minority report has, in part at least, just been upheld by two court decisions!

The Western Society of Engineers reviewed the majority report of this committee, pointed out its partisan character, and, in substance, upheld the minority by stating that the war construction program had been successfully carried out.

Congress in 1920 referred the Graham Committee report to the Department of Justice, with the recommendation that steps be taken to bring the guilty to justice. Evidently the Department could not find any guilty among the cantonment contractors, for after extensive investigation into at least two camps the cases were dropped as having no grounds for action.

ENGINEERING INVESTIGATIONS

There were two real investigations of the construction program and methods — real, because they were made by construction men of the broadest vision and experience.

In March, 1918, the Secretary of War invited the so-called Talbot Committee to advise in regard to the methods of execution of the work being done by the Construction Division. This committee made the first investigation and reported in favor of keeping on with the method then in use, namely, by using existing construction organizations working under a contract known as "Cost of the work plus a sliding scale percentage, with a maximum upset fee."

The members of this committee were —

A. N. Talbot, *Chairman*, President, A. S. C. E.

John Lawrence Mauran, *Secretary*, President, American Institute of Architects.

John R. Alpine, General President, United Association of Plumbers and Steam Fitters, representing A. F. L.

Frederick L. Cranford, President, General Contractors Association of New York.

Charles T. Main, President, A. S. M. E.

Oscar A. Reum, Representative of the President of Building Construction Employees Association of Chicago.

R. G. Rhett, President, Chamber of Commerce, of U. S. A.

E. W. Rice, President, A. I. E. E.

I think that you will agree with the Secretary of War that no stronger committee for the task could have been selected.

The second investigation was made by the Board of Review of Construction. This Board was composed of Francis G. Blossom, of Sanderson & Porter, New York, W. Saunders Davies, of Davies & Nield, Public Accountants, President of American Institute of Accountants, and Charles A. Morse, President of American Railway Engineering Association and Chief Engineer of the Rock Island Railroad.

This Board was appointed in July, 1918, by the War Department, not only to advise on methods and procedure for carrying on the construction program, but to investigate and report on the work which had already been done by the Construction Division and by all other Bureaus of the War Department.

This committee worked for more than a year, employing its own engineers and assistants. It had access to all the records of the government and of the contractors, and personally visited more than fifty jobs. It interviewed officers and civilians in many bureaus of the War Department. Its report stands out as a constructive summary of the lessons of the war in regard to the construction program, and should be of incalculable value in case of a possible future emergency.

The following quotations are from that 381-page report:

"The Board finds that the use of this form of contract, as finally developed, was well justified and contributed to the success of the emergency program; that by its use speed was obtained in war construction projects; and that it is probable that such work could not have been performed in the time available without it or its equivalent." . . .

"The Board of Review endorses and commends the action of the War Department in placing its construction work under one Bureau, entirely separated from the combatant units of the Army, conducted with a minimum of military control, according to modern business methods. The Board is of the opinion that such construction so placed was done with a remarkable speed, was superior in quality, was characterized by economy of design, and was as economically performed as the requirements for speed and other war conditions permitted. The facts ascertained and given in the accompanying report indicate that such construction performance contributed materially to the success of the Army operations."

SUITS AND INDICTMENT

In the fall of 1922, at the time that some members of Congress were advocating impeachment proceedings against Attorney-General Daugherty, the country was startled on several occasions by headlines in the Sunday newspapers announcing suits for great sums of money against some of the contractors who had built cantonments, and a criminal indictment for conspiracy against the former Assistant Secretary of War and some members of the Emergency Construction Committee. It was rumored that in filing these cases some of the machinery of the War Frauds Section of the Attorney-General's office had been by-passed.

The Attorney-General's office was represented in these cases by the same Mr. McCulloch who had been a member of the McKenzie congressional subcommittee investigating cantonment construction, and who had been defeated for the nomination for Governor of Ohio and had been given an appointment as Assistant to the Attorney-General. He was assisted by the same Mr. William T. Chantland who had been counsel for the McKenzie subcommittee.

The suits against the contractors are practically identical, except as to the amount of money in each case. The aggregate amount sued for on the 11 cantonments is \$55,000,000. The total cost of these 11 cantonments was about \$100,860,000. These contractors are being sued for more than half of the total cost of their jobs. When it is realized that about three-quarters of the materials were allocated at fixed prices by the Washington organization of the Cantonment Division, and that contractors merely received this material and paid the bills as audited by the government's representatives, and, further, that the rates of wages were fixed by labor boards in Washington, and that the contractors could work overtime only when authorized by the government's representatives, and that they paid their men on a payroll for which the time had been checked — and usually kept — by government representatives, the absurdity of these suits becomes apparent. But the amount of money these contractors have spent in preparing defences is not an absurdity, but a very serious consideration.

The suits are made up of general allegations of wrongdoing and abound in strong language. Every court before whom one of these cases has come has upheld the contractor's demand for a bill stating the specific crimes with which he is charged. The Attorney-General's office has not yet furnished in any case such a bill on which issue could be joined, and, therefore, no case has come to trial, and there seems no prospect of any getting to trial in reasonable or definite length of time. In every case where an opinion has been rendered it has favored the contractors.

In one case, that of Stone & Webster, Inc., which was sued for \$3,000,000 in connection with the construction of Camp Travis, Judge DuVal West of the United States District Court at San Antonio has dismissed the suit.

The following is quoted from his decision:

All of the defendants' other demurrers and their general and special exceptions are sustained, (1) for the same reasons as just above stated ("because the petition fails to state definitely and certainly the facts upon which the cause of action is based") and because (2) plaintiff's amended petition is so vague, indefinite and uncertain that the defendants are not informed of facts upon which the cause of action is based, and are unable to prepare their defensive answer. (3) Plaintiff declares that "it is impossible to itemize or particularize as to facts other than is set out in its amended petition" in Paragraph XIV. (4) Plaintiff seeks to recover damages occasioned by the alleged fraud and deceit of the defendants; the damages sought is the difference between the moneys paid defendants, ten million dollars, and the fair and reasonable value of the cantonment constructed. Such difference, or excess, is alleged to be three million dollars. This rule for measuring damages, even if a correct one, cannot be given practical application in this case. To do so would require a disregard of elementary principles of pleading as to definiteness and certainty; what evidence should be admitted under the pleading would be equally uncertain. Since it appears that it is impossible for plaintiff to itemize or further particularize as to facts, plaintiff's amended petition will be, and it is hereby, dismissed, with costs.

The representative of the Department of Justice has served notice of an appeal from this decision.

PUBLIC RESOLUTIONS ADOPTED

The time and the manner of bringing these suits and the indictment, and the wide publicity given them, made it look as if the purpose was to obtain something more than judicial results.

To those who were familiar with the facts of the war construction program and with the high motives which actuated the men responsible for that work, the conditions were revolting, because these suits and indictment in effect charged these men with being traitors to their country in its time of need.

The American Society of Civil Engineers, at their annual convention in January, 1922, passed a resolution affirming its belief in the integrity of those against whom accusations had been made and demanding prompt trial of the accused to the end that justice be done. This was followed by resolutions along similar lines from over thirty organizations of engineers, architects, contractors, and those in similar pursuits. The Affiliated Technical Societies of Boston passed a strong resolution on this subject, reciting that it spoke for the membership of our Society among others.

Promptly after the passing of the first few of these resolutions the announcement of additional suits against war construction contractors stopped and none has been made since.* From information received from well-informed sources I am sure that these resolutions did much good in stopping the announcement of other suits, and in bringing home to those in authority the fact that they would be required to back up their words.

The Department of Justice has been held in such high repute by the public that an accusation by it was regarded as establishing a fair probability of guilt. It was unique, and must have been disconcerting to the Attorney-General and his assistants, to have powerful organizations representing practically an entire industry rise up and assert their belief in the uprightness of the accused, and demand that the Attorney-General's office proceed promptly to produce what proof it might have.

The effect of this action on the part of the engineering and other organizations in aiding justice, cannot be doubted by any one familiar with this situation. This accomplishment alone is a powerful argument for maintaining the strength of our engineering bodies.

* Very recently a suit against one other contractor, who built Camp Meade, has been announced. It is similar to the other eleven and the amount is for \$7,000,000. It is interesting to note that this suit is announced at a time when Congress is again considering impeachment proceedings against Attorney-General Daugherty.

JUSTICE HOEHLING'S OPINION

In connection with the dismissal of the indictment against Mr. Crowell and others, I wish to give you what seems to me to be some of the high lights from the justice's opinion.

The attorneys for the defence summarized the charges against their clients as follows:

Passing the uncertainties and ambiguities in the indictment, which would be fatal to it as a pleading if otherwise sound, we come to two fundamental propositions: (1) the indictment improperly attempts to make the wisdom of an executive policy a matter for determination by a jury in a criminal court; (2) it proceeds on the theory that the provisions of Section 3709, the provision of the Act of May 12, 1917, and Sections 1493 and 527 of the Army Regulations were applicable to the emergency construction program during the war, whereas as a matter of law they were inapplicable, and consequently the adoption by the executive of the policy in question as to this program could not in any event be a defrauding of the United States of the due administration of these statutory provisions and regulations.

NOTE. — Sections 3709, 1493, and 527, referred to, provide for the use of competitive bidding in awarding contracts in peace time. Provision is made in these sections for the omission of competitive bidding in case of emergency. The Act of May 12, 1917, provided for the use of "cost-plus" contracts.

Quoting from the opinion of Justice Hoehling:

The government concedes that the indictment does not charge the defendants with a conspiracy to commit an offense or offenses against the United States; but as stated in the (Government) brief — "The indictment charges but a single offense, to wit, a conspiracy to defraud the United States by prejudicing the orderly administration of its laws by the regularly constituted officers and agencies."

Referring to the order of April 12, 1917, issued by the Secretary of War, announcing that an emergency existed within the meaning of Section 3907 and directing that contracts be made without advertising for bids during such emergency, the Justice says:

Counsel for the government frankly conceded that the language used by the Secretary of War in his said order was "quite unfortunate," as indeed

it was if it be now possible to disregard the plain language used and to engraft upon it exceptions and limitations long after the order has been executed and met a great national exigency and need, and served a great national purpose.

The court further says:

It occurs to the court that it would be a highly dangerous thing to submit to judicial review a question of departmental action and policy such as is here attempted.

The justice points out that the cost-plus contract had been, and was being, used by other departments, notably the Navy, even before the war, without any upset limit to the fee.

He discusses the Emergency Construction Contract with its safeguards and limited fees, and says:

It certainly must be well-recognized as a fact that, quite irrespective of any difference of opinion concerning the merits or demerits of the system, as viewed in the light of experience, the "cost-plus contract," as it was and is briefly described, was both extensively and successfully used (certainly to the extent of producing results), during the great emergency of the war as a means for securing a great many of the facilities and instrumentalities for successfully carrying on the war.

And further on says:

From a reading of the provisions of the contract, and in the absence of any direct specification of objection, the same would appear reasonably to safeguard and protect the interests of the United States.

He further points out that the Emergency Construction Contract was formally approved by Secretary of War Baker, and comments rather bitingly on the failure of the indictment to mention this important fact, which was a matter of record.

He quotes about five pages from the reports of the Secretary of War to the President, ending with the following quotation from that report:

In spite of the stupendous difficulties involved, the entire housing enterprise was completed on schedule, constituting one of the most remarkable accomplishments of the war.

And, lastly, he states:

The court is of the opinion that while the indictment abounds in the statement of conclusions, it fails to support the same by facts alleged as re-

quired in a criminal pleading; and, furthermore, it is sought herein to obtain a judicial review of the policy adopted by the Secretary of War concerning the war emergency building construction program of that Department throughout the period of the late war; and that too in the absence of fact allegations that would make such review proper; even assuming, but not hereby deciding, that the question is one open to judicial review.

I said in the beginning that the whole construction industry had been indicted. It has been. Several of its most capable and prominent members have been under legal indictment before the courts. Several of the greatest construction companies in the country have been, and some now are being, sued before the courts for huge sums. I say, also, that the honesty, integrity of purpose, and ability of all in the construction industry have been assailed by the attack made on these leaders of the profession who served on the Talbot Committee and on the Board of Review of Construction, who are slandered by innuendo and by the statement that certain members of each of the committees were "interested in such contracts and system." In assailing these men who hold the highest professional honors which the engineering profession had to give, they assailed us all.

Now Mr. Crowell and those accused with him have been exonerated by the Judicial Department. Now, also, one of the suits against a contractor has been dismissed by the Judicial Department, and I predict that the remaining suits will likewise be dismissed.

The construction industry, including these indicted men and sued firms, was cleared, and more than cleared, before the bar of public necessity by its performance in 1917 and 1918. It is now in process of getting that verdict ratified by the courts of this country. Such a ratification is a slow and expensive process, and should not have been necessary.

ODOR ELIMINATION

BY ALMON L. FALES,* MEMBER, BOSTON SOCIETY OF CIVIL ENGINEERS

(Presented before the Sanitary Section, February 6, 1924.)

IN his paper on "Present Status of Sanitary Engineering," presented at the meeting of the Sanitary Engineering Division of the American Society of Civil Engineers on January 16, 1923, Harrison P. Eddy (1)† classifies the problems of sanitary engineering in five principal divisions: water supply and purification; sewerage, drainage and the disposal of sewage and industrial wastes; refuse collection and disposal; eradication of the mosquito and other vermin which may carry infection; and air supply and purification. In this last division belongs the elimination of odors.

The term "elimination of odors," like the term "purification of sewage," is not strictly accurate. Sewage is not purified in the sense that the effluent is pure, and odors are not of necessity completely eliminated to remove objectionable conditions. In some cases the solution of the problem will be prevention of the production of the odors. Perhaps the term "control of odors" is more accurate, but "odor elimination" is more suggestive of the ideal result to be accomplished.

The scope of this paper will be limited to a few important preliminary considerations, a brief account of the nature of odors in general, a general description of possible methods of odor elimination, a discussion of some of the principal sources of objectionable odors, including sewage treatment plants, garbage disposal works, and certain industrial plants, particularly packing houses and allied industries, and some suggestions with reference to study and research as well as practical investigations and tests to advance the art of odor elimination.

* Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

† The figures in parentheses refer to the Reference List on page 176.

PRELIMINARY CONSIDERATIONS

Pollution of Air. — The air is polluted by odors, fumes and dust in much the same way as streams are polluted with sewage and industrial wastes. Objectionable discharges into the air are carried by the wind current until dilution and decomposition cause them to become unobjectionable. The distance to which such objectionable discharges are carried depends largely upon the velocity of the wind, but a very high velocity is apparently advantageous, as in the case of a polluted stream. Cool temperatures are favorable in both cases. There is this difference, however: the course of the polluted stream is definite and fixed, whereas the direction of flow of polluted air currents is variable, depending upon wind, barometric pressure, humidity, temperature, topographic conditions and other factors. The area affected by a source of odors extends in all directions. It is therefore much more difficult to determine the source, extent and effect of pollution by odors.

Distinction between Odors, Fumes and Dust. — Strictly speaking there is a marked distinction between odors, fumes and dust. Fumes and dust, although they may have distinct odors, produce other entirely different objectionable effects, such as irritation of eyes, nose and throat. From the health standpoint it may be much more important to eliminate fumes and dust than odors. So far as treatment to remove the objectionable effects is concerned, they may all be considered in the same category. True odors, however, are not so easily measured and analyzed, so that the problem of their elimination is likely to be more difficult.

Relation of Odors to Health. — A generation or two ago it was believed that foul odors were the source of contagious diseases. As late as 1895 a state board of health attributed malaria to the polluted condition of a stream passing through a meadow. The filth theory of disease has been exploded, and there has been a tendency of late to consider odor nuisances as independent of the public health. Dr. C. V. Chapin (2) in an address before the American Public Health Association on October 11, 1923, states as follows:

Offensive trades furnish the most difficult nuisances with which we have to deal. The odors from the use of fuel oil recently consumed a large part of my time for six months. The State Health Department of Massachusetts was obliged, not long since, to devote much time to another type of oil nuisance, and I have known the same department to waste days on other offensive trades, the control of which was, by law, placed upon it. In cities such nuisances should be abated, but this should be a function not of the health department but of the engineering department, which is far better equipped to deal with them. (Page 2.)

Bad odors are practically harmless. (Page 3.)

On the other hand, Professor George C. Whipple, in an address before the Sanitary Engineering Division of the American Society of Civil Engineers on January 15, 1924, includes in his classification of environmental factors which affect health sensory factors including smell. He places emphasis on sanitation as an agent in promoting health, as well as in protecting against disease, and objects to the threatened administrative cleavage between the public health and sanitation. In an earlier discussion on the subject of odors, Professor Whipple (3) refers to their effects on health as follows:

In a physiological sense, meaning a condition of the body in which it operates normally, the effect of odors on health is ordinarily slight; often there is no effect. Yet intense odors may cause reflex actions of the digestive, muscular, and secretory systems. A vile odor may make one sick to his stomach or cause him to close his nostrils with his fingers, or run away. Even bad odors, however, do not cause disease, as the term is ordinarily understood; they do not shorten life. The irritants may cause smarting sensations and respiratory discomfort, and probably are more closely related to health than true odors. Offensive odors may cause people to refrain from breathing deeply, may cause loss of sleep, restlessness, loss of appetite, and general malaise. These are certainly matters which appertain to health, and to some people they are of serious import.

If, however, the word health is extended to include the psychological as well as the physiological, if it includes human comfort as well as bodily functions, then odors do have an important influence on health. In addition to what has been mentioned, odors have strong powers of suggestion, and give pleasure, discomfort, or disgust, as the case may be. They may interfere with one's quiet and repose. (Pages 395-396.)

It is not within the scope of this paper to discuss at length the relation of odors to health, but the writer wishes to take this

opportunity to support Professor Whipple's view that sanitation should not be divorced from the public health. The importance of sanitation, including good air, as well as pure food and clean water, must not be belittled.

Importance of Odor Elimination. — Even though the public health be not directly affected by offensive odors, the public comfort must not be neglected. The inalienable right of "the pursuit of happiness" must not be interfered with. Odors which make life miserable should not be tolerated. The offender, if he is wise, will not wait until litigation ensues, but will take immediate steps to remedy the trouble. The rising standard of living must be recognized and respected. In the establishment of sewage-treatment plants, garbage-disposal works and the so-called offensive trades particular attention should be given to their location, as "an ounce of prevention is worth a pound of cure." There are districts which are appropriate for such plants and others which are not. However, a favorable location at the time of construction may become an objectionable one through the building up of residential districts in the vicinity. In any event, the owners of such plants must recognize their obligation to take all reasonable precautions against the dissemination of offensive odors.

The problem is complicated by the fact that odors from a particular industry may not be considered offensive by those engaged in that industry because they have become so habituated to them that these odors no longer cause an unfavorable reaction. At the same time such people may complain bitterly of the offensive odors produced by neighboring industries when the unprejudiced observer would class the former industry as by far the greater offender. However, where a whole community is largely dependent on an industry, its odors may be tolerated as a necessary evil.

The same odor may react quite differently upon different people, according to their susceptibility, occupation, race and environment. However, an offensive odor is generally recognized as such by substantially all normal unprejudiced observers. If it has not been recognized by the offender himself, it is quite sure to be called to his attention by complaints from his neighbors.

NATURE OF ODORS IN GENERAL

In order to appreciate the problem of odor elimination, it is necessary to consider the nature of odors in general. Professor G. H. Parker, in his new treatise on "Smell, Taste and Allied Senses in the Vertebrates," furnishes much helpful information.

Cause. — Professor Parker states that it is now the general opinion that odors are produced by emanations of minute, often infinitesimally small, amounts of matter, although these amounts include very large numbers of molecules. This view is borne out by the fact that odors do not disperse in all directions from the source, as in the case of sound and light. Air currents are the chief, if not the sole, factors in transporting the odorous particles to the olfactory membrane. In order to produce an odor these particles must be soluble in oily liquids, such as those secreted by the olfactory organs. The accumulation of odorous particles on the olfactory surfaces is much increased by the condensation of moisture within the nasal cavity. This is one reason for the intensified odors always noticed in humid weather. Moisture appears to be necessary, but is normally present both in the atmosphere and on the mucous membranes.

Classification. — Odors are commonly described in terms of the odorous substances from which they are derived, as the odor of violet, of onion, of tar, etc. Odors may come from solid, liquid or gaseous forms of matter, but apparently they cannot be classified according to these sources.

The most scientific classification as given by Professor Parker is that of Henning, who divides the odors into six fundamental classes, as follows:

1. Spicy odors, such as those of fennel, sassafras oil, anise, and cloves.
2. Flowery odors, such as those of heliotrope, cumarin, and geranium oil.
3. Fruity odors, such as those of oil of orange, citronella, oil of bergamot, and acetic ether.
4. Resinous or balsamic odors, such as those of turpentine, of Canada balsam, and of eucalyptus oil.
5. Burnt odors, such as those of tar and pyridine.
6. Foul odors, such as those of carbon bisulphide and of hydrogen sulphide.

Although each of these six classes, according to Henning, is represented by a number of odors, it is not absolutely separated from the others, but between any pair of them there are numerous odors that assume intermediate positions. The six classes, however, are the striking predominant elements in this complex, and are in no sense submerged in the general array of odors.

Henning has tried to make clear his idea of the relations of these six classes by imagining them located one at each corner of a three-sided prism, which he calls the olfactory prism. From each corner of this prism lines may be imagined to pass out to the other corners; these lines traverse either the edges of the prism or pass over its faces and mark the positions of all intermediate odors. Thus all odors, be they fundamental or intermediate, find places on the surface of the prism. Relations indicated by lines within the prism and connecting any two points on its surface indicate only mixed odors. Thus by means of a figure of three dimensions Henning brings into clear view the relations he conceives to exist between the six fundamental odors, their intermediates and mixtures. So far as an arrangement of odors is concerned the clarity of Henning's scheme is at once its most attractive and most suspicious feature. (Pages 74 to 76.)

Professor Parker states further that it is admitted on all sides that olfaction is essentially a chemical process. Henning's classification is based on his studies of the relations of odors to chemical constitution, from which he concludes that odor is not associated with any particular osmophoric group or radicle, but rather by its position on the benzene ring. He points out in a general way the positions occupied by the osmophoric group for his six classes of odors. For example, in the "burnt odors" the ring is smooth, as in pyridine, and in the "foul odors" the ring is fragmentary, as in cacodyl. Intermediate odors he considers due to combinations of groupings.

Intensity. — Odors vary not only in kind but also in intensity, according to the nature of the substance producing the odor. Artificial musk is probably the most powerful of all known odorous materials, but this is considered a pleasing odor or perfume. Mercaptan, a liquid with a penetrating garlic odor, is not so powerful as musk but has been recognized at a concentration of 1 grain in 390,000,000 gallons. This shows how little of a substance may be required to give an odor.

The intensity of odors is materially affected by temperature. Odors which are very pronounced at warm temperatures may not be noticed at very cool temperatures. This is probably due in

part to a lower sensitiveness of the olfactory membranes in cold air, and in part to a slower rate of volatilization of the odorous particles at low temperatures. This is particularly noticeable in the case of water or other liquids in which the odors may not appear until the liquid is heated, and if observed in the cold liquid will be much increased by heating it. Also, when the rate of evaporation or volatilization is increased by heating under a vacuum the intensity of the odor will be greatly increased.

Analysis. — Odors are not subject to quantitative analysis as the personal equation enters. For the same reason it is very difficult to classify odors as to their reaction upon human beings. Smells which are pleasing to some may be disagreeable to others and *vice versa*. Too much of a pleasant smell may become disagreeable. A whiff of an odor may be worse than the concentrated smell, although the reverse is generally true. Persons whose occupations lead them to work among disagreeable smells soon become insensitive to these, due, as Professor Parker explains, to the fatiguing of the olfactory organs by continued exposure to the odorous particles. For this reason it is unwise to entrust an odor investigation to one who has been constantly in contact with the odors.

For the purpose of the study of the odor elimination problem we are primarily concerned with objectionable smells. Some are much more objectionable than others, and it is desirable to classify them in some way both as to kind and as to degree. In spite of differences in reaction upon different individuals it seems most practical to classify these odors as disagreeable, offensive and very offensive or nauseating, as they would appeal to the average person. The degree of the odor may be designated by the terms slight, distinct, decided and extreme.

For the sake of convenience the word "odors" may be used where "odorous particles" are meant.

Mode of Transmission. — As previously stated, odors may be caused by solid, liquid or gaseous particles. Humidity apparently acts as the principal carrier unless the odorous particles are already in the form of vapor or are held in solution by water vapors. If insoluble in water they will be carried through the atmosphere mechanically or by means of surface tension of the

water particles. As previously stated, wind currents are the agents of transmission of odors.

Odors travel farthest under conditions of low barometric pressure and high humidity. There are apparently great differences in the carrying power of odors; some are quickly dissipated, while others proceed for long distances. It is probable that the odors emanating from pure gases are much more rapidly dispersed than those resulting from solid or liquid particles, which are more readily transported by the wind currents.

Mixing of Odors. — If two odors, one of which is much stronger than the other, become mixed the stronger odor will completely mask the other. If the odors are closely balanced another odor may result, unlike either component. If chemical action takes place between the two sets of odorous particles, a different substance will be produced, which may or may not have an odor of its own.

Professor George C. Whipple (3) in his studies of odors of organisms in water observed that as odors decreased in intensity they changed in quality, this phenomenon he attributed to the fact that few odors are due to a single substance but rather to mixtures, so that when they are diluted the weakest constituents lose their effect first.

Effects of Objectionable Odors. — The effects of a bad smell are discomfort, loss of appetite, headache, nausea, and nervous disorders, depending upon the character of the smell and the susceptibility of the person affected. Odorous substances may have an irritating or poisonous action, but such action is not the effect of true odor.

Dust may or may not have an odor, but in any case it is objectionable in its effects if present in considerable amounts. Fumes or corrosive gases may have an irritating effect as well as an odor, and the former may be more serious than the latter. For practical purposes dusts and fumes must be considered in any problem of odor elimination.

METHODS OF ODOR ELIMINATION

Removal of Primary Cause. — The first consideration in the elimination of odors is the removal of the primary cause as far as it is practicable to do.

In cases where the odors are due to bacterial decomposition of organic matter, it is important to handle the substances, both solids and liquids, before they have time to decompose. It is necessary to keep vats, kettles, tanks or other containers for putrescible matters in clean and fresh condition by frequent cleaning. Floors upon which such substances have opportunity to fall must be thoroughly cleansed at frequent intervals.

The construction of buildings in which offensive odors are created is an important matter. Pervious materials like wood absorb odors and continue to be a source of offense even after washing. Applying jets of air is more effective than washing for removing odors in such cases, but this is only a temporary remedy. The use of disinfectants and deodorizers may also be effective as temporary expedients. It is very desirable that such buildings be of reinforced concrete construction. Floors and walls of smooth impervious materials, such as dense cement mortar or vitrified paving brick, are most suitable. The floors should have good draining qualities so as to prevent pooling and to conduct any liquids or wash waters promptly to the drains. The drains should be protected by adequate screens or gratings, to prevent deposition of solids in them.

Collection of Odors at Source. — In the case of offensive odors incident to a process it is important to collect the odors at the source for special treatment rather than to allow them to mingle with the air and depend upon processes of treatment of relatively large volumes of malodorous air. For this purpose there may be employed direct piping from tight kettles or tanks and hoods over open kettles or tanks, with special ducts and fans to create the necessary suction. It is very important to keep such apparatus, piping and ducts tight so as to prevent leaking of the offensive odors.

The available methods of treating the odors so collected will be discussed later.

Ventilation. — When it is impracticable to remove all causes of objectionable odors, or to collect all such odors at the source for special treatment, particular attention must be given to ventilation. This involves the collection of the air from all parts of rooms where objectionable odors are created, and prevention of the escape of these odors into the open air. It is much more effective to draw the air to a single point for such treatment as may be necessary than to depend upon devices for disinfecting or deodorizing the air in different parts of the room, although such devices may be valuable adjuncts when judiciously located.

To accomplish efficient ventilation without the escape of odors the fan system must be so designed that the rooms will be kept below atmospheric pressure by providing greater outlet capacity than intake capacity. By this system, if a door is opened to the outside the outside air will rush in instead of the inside air and odors passing out. The air inlets and outlets must be properly located to secure complete circulation of air within the rooms, and the air inlets must be regulated to secure a continuous in-draft. The windows not used for air inlets should be kept tightly closed, and the doors should be well fitted and provided with heavy springs to keep them shut unless held open for purposes of ventilation. Two sets of doors with a space between sufficient to keep one set closed all of the time may be of great assistance. For purposes of ventilation, wall fans may be an important adjunct in the accomplishment of the desired ventilation. It is important not to over-ventilate some rooms at the expense of others unless this is desirable on account of more odors in some rooms than in others.

The desirable fan capacity for the outlets will depend upon the capacity of the rooms and the extent of odors produced, and whether treatment other than air dilution will be required. If such treatment is necessary it is advisable to limit the fan capacity to the amount of air required for the health and comfort of the employees. If air dilution is sufficient treatment, aided if necessary by simple means of deodorization, it will be advisable to provide large fan capacity perhaps sufficient to change the air every few minutes.

Air Dilution. — In cases where there are only slight odors simple air dilution may be effective, particularly if these odors have little carrying power. In such cases it is desirable to use a relatively large volume of air in ventilation as previously stated, in order to discharge into the atmosphere a dilute mixture of the odors so that they will be dispersed more readily before they are carried away by the wind.

In cases where the objectionable odors are more than slight, especially if they have considerable carrying power, treatment other than air dilution will be required.

Deodorizing. — For air having only a slight odor it may be possible to eliminate this by a suitable deodorant, such as phenol, creosote oil, pine tar oil and the like. "Pyrol," a coal tar oil, and "Westopine," a wood tar oil, have commonly been used for this purpose.

For complete deodorizing it is essential that the deodorant be thoroughly mixed in requisite proportion with the air to be treated. The simplest method appears to be by passing the air over the steaming deodorant and baffling the air conduit in such a way as to secure complete mixing before it is discharged into the atmosphere. The surface of the steaming deodorant must be large enough to furnish an amount of deodorizing vapor sufficient for the volume of air to be treated. The steaming is preferably effected in steam-jacketed boxes, as the condensate from live steam causes the boxes to overflow. Wooden boxes are often preferable because of corrosive action on metals. The deodorant must be added at frequent intervals to maintain its deodorizing power.

Deodorants may act in three ways: first, masking the objectionable odor with a more powerful but agreeable odor; second, by disinfecting odorous particles and thereby arresting further decomposition; and third, by chemical action, thereby changing the odorous particles into inodorous substances. The above-mentioned deodorants have more or less disinfecting action, but the extent of such action in the elimination of odors is uncertain. Direct chemical action is probably not a factor.

To be satisfactory the resulting odor must be unobjectionable after dilution and diffusion in the air.

Disinfection and Chemical Action. — Certain substances, such as formaldehyde, chloride of lime, liquid chlorine, sulphuric acid, and sulphur dioxide gas, accomplish deodorization not by masking the odors but by destroying the bacteria of decomposition, and possibly also by direct chemical action with, or oxidation of, the odorous particles.

Wallace & Tiernan Company, Inc., of Newark, N. J., have adapted their water chlorination apparatus for the deodorizing of obnoxious air, vapor or gases. Provision is made for thorough mixing in special chambers of the chlorine gas with the air, vapors or gases to be deodorized. In this case the deodorizing is accomplished not by the masking of odors, as chlorine gas itself has an irritating effect, but the chlorine is apparently used up in the disinfection and oxidation of the odorous particles.

For the treatment of obnoxious gases and vapors the Mac-lachlan Reduction Process Company, Inc., New York City, applies a mixture of live steam and sulphur dioxide gas in a specially designed mixing chamber, followed by a condensing chamber or standpipe equipped with water sprays.

Incineration. — One of the most effective methods of elimination of obnoxious odors is the burning of the odorous particles carried by the air, vapors or gases. To accomplish this it is essential that the temperature of incineration be high enough to effect complete combustion. To be successful no considerable amount of objectionable fumes should be created by the incineration.

In cases where boiler plants providing the requisite temperature are available it is feasible to discharge the bad-smelling air or gas into the ash pit and utilize it as forced draft up to the capacity of the plant. Vapors so discharged in coal-burning boilers will assist in preventing the formation of clinker, but may have a corrosive action on grates and possibly also on the boiler flues.

Washing or Scrubbing. — In cases where the available boiler capacity is insufficient or the temperatures too low for complete combustion of the odorous particles, or if irritating gases are produced thereby, washing or scrubbing may be resorted to either with or without prior incineration and subsequent deodorizing.

This consists in passing the air, gases or vapors through sprays or sheets of water. To be effective the odorous particles must be removed either mechanically or by solution in water. Insoluble odorous gases cannot be so removed.

The washing may be done in a horizontal chamber provided with banks of water spray nozzles and mixing baffles, or in a tower. If a tower is used the air, gases or vapors are discharged into the bottom and pass upwards, coming in contact with the falling water. Either banks of spray nozzles or overflow troughs with baffles in the tower may be used. The former is generally more efficient and more economical in the use of water. The coke scrubber is effective, but for some uses may itself become a breeding place for bacteria and a consequent source of odors. It also furnishes great resistance to the upward passage of the gases. In Germany such towers have been built of "raschig rings" which are simply pipe nipples, say one inch in diameter and of the same length, presenting a maximum of surface with a minimum of resistance.

In cases where water alone is not effective some chemical, such as chloride of lime, may be added to the water.

An open chamber without suitable baffles is very inefficient in the removal of dust. Most of the air-washing devices are consequently designed to remove dust also. The modern type of air washer consists of chambers with water sprays followed by baffle-plates or eliminators producing sudden changes in the direction of flow of the air currents to effect the deposition of water and dust particles by centrifugal action.

Dust Removal. — The various types of apparatus for removal of dust from air are described by E. R. Knowles in an article on "Dust, its Universality, Elimination and Conservation" (4).

One of the earliest forms is known as the Centrifugal or Cyclone Separator, which is in the form of a metal cylinder with hopper bottom. It is so constructed that the air or gas is blown through the inlet on the side nearest the top, striking against the opposite wall tangentially, which gives it a spiral downward direction in the cylinder, and it then passes upwards through the center and out at the top. There are various improved forms of this type of apparatus. Some of these are provided with spray

nozzles pointing in the direction in which the air or gas rotates, through which water is discharged in a fine spray, and this materially assists in the removal of the dust.

Various dust separators are in the form of chambers with baffle-plates, water sprays and deposit tanks, the dust particles being caught by the baffle-plates, from which they are washed by the water streams into the deposit tanks. This type has previously been referred to under "washing."

Another type is the bag or filter system, the dust-laden air or gases being drawn through cotton or woolen bags.

A very different method depends upon the use of the electric current, and is known as the electrostatic method of dust separation, often referred to as the Cottrell System. This method consists in passing the dust-laden air or gases between series of electrodes connected to the poles of a high tension (15,000 to 70,000 volts), direct current. The dust particles become charged with electricity and pass to the electrode of the opposite charge from which they are dislodged by jarring.

In addition to the fixed dust separators there are the high-speed rotary separators operated on the centrifugal principle, with spray nozzles for washing.

The Baldwin Separator, highly commended by Mr. Knowles, consists of three principal parts: a suction fan, a perforated cylindrical drum surrounding and forming an integral part of the fan and revolving therewith, and an enclosed shell or housing. The air or gas is drawn through the inlet at high velocity by the rotating fan and then changed in direction of flow, the centrifugal force imparted by the fan blades throwing dust particles at high velocity against the perforated drum and through the perforations into the collecting chamber, where they fall to the bottom. In some cases, where the dust particles are very fine and of light weight, it is necessary to use a spray of water to give weight enough for their removal.

J. L. Alden (5) describes a "high speed air and gas washer" in which the air is given a whirling motion thereby throwing particles of dust against the walls, a water spray being used for washing. He states that only one to one and one-half gallons of water are required for 1,000 cubic feet of air. The disadvantage

of this type, especially when handling large volumes of air, is the high velocity required.

Disinfection of Substances causing Odors. — It is very desirable to prevent the production of foul odors by disinfection so far as this is practicable. There are numerous disinfectants, such as phenol, formaldehyde, chloride of lime, liquid chlorine, and sulphur dioxide gas, already mentioned.

The spraying of floors where putrescible matter finds lodgment with phenol, chloride of lime and the like will be very helpful. When animal matter has to lie exposed for some time, covering it with some disinfecting substance, such as chloride of lime, is very advantageous.

Wallace & Tiernan Co., Inc., of Newark, N. J., has devised apparatus for applying chlorine gas to contaminated water or other liquids containing bacteria for the purpose of disinfection, and this apparatus is very effective when properly operated.

The Maclachlan Reduction Process Company, Inc., of New York City, has developed a process of treatment of the offal in rendering tanks by a mixture of live steam and sulphur dioxide gas which, it has claimed, practically eliminates all objectionable odors from rendering and subsequent processes.

The process employed by this company for steam-jacketed tanks involves treating the vent gases and vapors with the gas-steam mixture in a mixing chamber, followed by a condensing chamber or standpipe provided with water sprays.

Treatment of Liquid Wastes. — Those liquid wastes which have so strong an odor as to be objectionable in the sewers may be deodorized to a greater or lesser extent by treatment with such chemicals as lime, chloride of lime, liquid chlorine, sulphuric acid, sulphur dioxide gas and caustic soda. The most effective chemical to use will depend upon the character and composition of the particular wastes to be treated. Care will have to be taken not to use chemicals of such kind or in such amount as to have any serious effect upon the materials of which the sewers are constructed.

The action of these chemicals is to destroy all the odor producing bacteria, or by chemical action to convert the substance which is responsible for the odor into some other sub-

stance which does not produce odor. The former action is nullified to a large extent by the contribution of bacteria in the sewage with which the wastes become mixed. Subsequent dilution with other wastes may also revive the objectionable odor or create other bad smells. These facts must be taken into consideration in the solution of problems of treatment of wastes.

It is important that the wastes, unless specially treated, be discharged into the sewers as promptly as practicable. It is necessary, however, to remove the solids, which are likely to clog the sewers or to form deposits in them. Screening or settling, or both, in a general catch basin or sedimentation tank may accordingly be required.

It is important to remove from catch basins the putrescible deposits or sludge and the floating matter or scum at frequent intervals in order to avoid unnecessary decomposition of the solids, which results in the production of offensive odors and renders the wastes discharged into the sewer more objectionable in character.

In certain cases it is desirable to have separate catch basins for the wastes of different character as close to the source as practicable. These as well as the general catch basin should be thoroughly cleaned and washed every day. In cleaning, care must be taken not to flush an undue amount of solids into the sewer. The screenings, skimmings and deposits from catch basins should be taken care of promptly, utilizing material of value and disposing of the remainder promptly.

If in spite of as effective removal of solids as practicable, by screening and settling in catch basins, deposits of putrescible matter occur in the sewers, due to insufficient velocity of flow afforded by the sewer design, it will be necessary to clean or flush the sewers at frequent intervals.

In spite of all reasonable precautions the wastes may have more or less objectionable odor, but if they had not there would be the objectionable sewer gas smell from the sewage proper. It is therefore important to provide tight covers for the manholes on sewers as far as practicable, and avoid artificial circulation of air through the sewer by down-draft in some manholes

and updraft in others. It is particularly important that manhole covers be tight where there is a material drop from one sewer to the other, thus causing agitation of the sewage and the release of odors.

SOURCES OF OFFENSIVE ODORS

As previously stated, offensive odors are created not only by the putrefaction of animal or vegetable organic matters but also by various processes of conversion of raw materials into food, clothing, metal, chemicals, oils, fertilizers and innumerable other commodities.

Certain industries, such as grain mills, sugar refineries, woolen mills, cotton mills, paper mills and shoe factories, produce characteristic odors which are not generally considered offensive. Certain other industries, such as soap factories, tanneries and glue works produce more or less offensive odors, but communities in which such industries are located have become accustomed to these odors and tolerate them, although such industries on locating in new districts would be likely to be complained of. Certain other industries, such as slaughter houses, rendering works, packing houses, fertilizer works, oil refineries and chemical manufacturing plants are likely to produce intolerable smells unless special provisions are made to eliminate the odors. Sewage treatment plants and garbage disposal works have been among the greatest offenders.

On November 6, 1922, Louis L. Tribus (6) presented a paper before the American Society of Civil Engineers on "Odors and their Travel Habits," which was discussed by a dozen different men from their own experiences.

Sewage Treatment Plants. — Sewage and industrial wastes discharged into streams or bodies of water have given rise to serious troubles from foul odors in many places, although the odors from such sources have not generally been carried very long distances. Massachusetts has had a number of examples of such streams. George A. Soper (7) states that there are frequent times when the smell of sewage is noticeable along miles of the Manhattan water front, and that some of the recreation piers have sewers discharging directly under them, the nauseating

odors from which assail thousands of visitors at the times when these breathing places are most needed.

Sewage and industrial wastes treatment plants have generally been built to prevent offensive odors from streams or bodies of water into which the sewage or industrial wastes had been discharged without treatment. In some cases the treatment plant has caused more trouble from odors than had resulted from the conditions which the treatment plant was built to remedy. Some types of treatment plants are subject to very offensive odors, while others are relatively free from them. Any type of sewage treatment plant is subject to offensive odors under conditions of mismanagement or improper operation.

The type of sewage treatment plant to be built must be considered from the point of view of location and danger of complaints on account of odors, but no treatment plant can be considered entirely satisfactory which does not accomplish the desired degree of purification without the production of seriously objectionable odors. It is not within the scope of this paper to consider at length the relative merits of the various types of sewage treatment plants, so far as odor production is concerned. It is only necessary to point out the chief dangers of odors from such plants.

If sewage (or putrescible industrial wastes) is detained in tanks so long that putrefaction takes place, or if allowed to come in contact with putrefying sludge deposits, it is likely to create serious trouble from offensive odors, particularly when sprayed upon trickling filters. Offensive odors from this source have been observed over one-half mile from the plant. If undigested sludge or scum is allowed to putrefy in contact with the air, as in sludge lagoons or on sludge drying beds, it is likely to be a very serious source of offensive odors. If the sewage is kept fresh and the sludge well digested or handled very promptly in a fresh condition, there will generally be no need of further provision to eliminate odors.

It sometimes happens that the sewage as received at the treatment plant is already in a foul condition, due to the presence of offensive industrial wastes or to long detention in relatively large sewers, especially when in contact with decomposing

deposits resulting from insufficient velocity of flow. Special precautions may then be necessary.

Sewage treatment plants are sometimes shielded by the planting of trees, to lessen the effect of winds in the dissemination of odors. Tanks and sludge beds have sometimes been covered for the same purpose. Andrew J. Provost (8) states that he has housed sprinkling filters as well as sludge beds to prevent the dissemination of odors in settled communities.

Sewers themselves have sometimes been sources of various troubles from odors escaping through perforated manhole covers or gutter inlets. Alexander Potter (9) cites a case where foul odors produced by deposits in certain laterals where the house connections were trapped were carried down the main sewer a considerable distance, where they escaped into the atmosphere and caused complaints. The trouble was remedied by frequent removal of the deposits and elimination of the house traps, so that the gases were vented through the stacks.

The writer had occasion to investigate the sources of odors in the west district of Toronto, Can., and found odors from packing house wastes rising through various perforated manhole covers on the trunk sewer to a distance of several miles from the packing houses. At some manholes there was a down-draft and at others vapors laden with the smells were rising in front of attractive residences. The remedy recommended was replacement of the perforated manhole covers with solid covers in front of residences, and treatment of the wastes to reduce odors.

Garbage Disposal Works. — Garbage when allowed to remain in a warm place for any considerable time begins to ferment, with the production of a foul, sour smell, which is familiar to all. Garbage disposal works have probably given more serious troubles from odors than have sewage treatment plants. Garbage has generally been disposed of in one or more of the following ways: feeding to hogs, dumping and burial, incineration, and by reduction processes.

Feeding to hogs, although it has sometimes been profitable, has frequently been attended by offensive odors, not only from the fermenting garbage itself but also from the hog manure, which may be even more offensive. If the garbage is handled fresh,

before it has time to ferment, and if the hog pens are properly constructed and kept dry and clean, this method of disposal may be carried out in suitable localities without serious trouble from odors. It has grave potential dangers if operated for profit without proper regard for sanitation.

Dumping affords a sanitary method of disposal if the garbage is handled fresh and promptly buried. This method, of course, requires suitable dumping ground.

High temperature incinerators (above 1,250° F.), properly controlled, have been found to be fairly free from offensive odors. If the temperatures are too low, pungent and offensive smells are created and carried long distances. This method is commonly applied to mixed household refuse, which has considerable fuel value. Studies made by the firm of which the writer is a member, in connection with the problem of garbage disposal at Buffalo, N. Y., led to the conclusion that incineration of garbage alone, without the addition of fuel and without creating offensive odors, would be impracticable, but that with certain methods it is possible to dry the garbage without creating offensive odors.

Reduction processes have given rise to serious trouble from odors in numerous cases. The odors which have come from the Boston plant at Spectacle Island are too well known to require any description.

Louis L. Tribus (6) cites the case of the Barren Island plant in the Borough of Brooklyn, city of New York, the fumes from the retorts and tankage driers of which, passing off in part through chimneys, were carried five or six miles, where they were scarcely less offensive than at the plant. He also refers to the great reduction plant built at Lakes Island, to replace the Barren Island plant, which for several months before it was shut down by order of the courts gave off odors that persisted in nauseating quality and strength to points eight or nine miles away. The odors settled in topographic and atmospheric pockets, where they caused severe headache, nausea, lassitude and general violent wrath. Three kinds of smell were distinguished — caramel or burning vegetable matter; semi-rancid decomposing swill; and odor of the solvent, which was midway between gasoline and kerosene.

In discussing Mr. Tribus' paper I. F. Osborne (10), who had to do with the design of this plant and putting it in operation, states that if the plant had been properly operated it would not have been the source of serious trouble, as all reasonable means had been provided to prevent the escape of odors.

Reduction processes vary, but commonly consist of digester and drier systems in which the garbage is cooked and then pressed and dried. Odors come from the raw garbage as delivered, exposure of materials during the process, leaks in the apparatus, vents from digesters where live steam is used for cooking, and gases from direct-heat driers. The principal sources of odors are the vapors and gases vented from the digesters and vapors from the driers. The vent gases are the most offensive, but are more easily controlled and treated than the much larger volumes from the driers, which have a sweetish caramel odor.

The Cobwell process uses a steam-jacketed reducer, in which the cooked garbage is treated for the removal of grease by a solvent which acts also as a dehydrating agent. Water and solvent vapors from the reducer pass to a condenser, which removes practically all the odors.

The Cobwell-Merz system, which was under consideration at Buffalo, employs preliminary rotary dehydrators (direct heat driers) the vapors and gases from which are passed through scrubbers and the washed gases discharged through a closed chamber, in which chlorine gas is introduced to eliminate the odors. This method of chlorine treatment has been used at New Bedford for some time, with satisfactory results.

Investigations conducted at the Central Testing Laboratory, Barren Island, New York City, on the dilution of garbage tankage drier gases with air, led to the conclusion that for these no reasonable amount of dilution with air is effective. The obnoxious odors were completely eliminated at a temperature of 1,850° F. Below this temperature there was an acrid, irritating odor. The experiments on incineration of garbage digester vent gases showed that the obnoxious odors disappeared at a temperature of 1,200° F., but were replaced by irritating sulphur dioxide fumes, which increased with increasing temperature. Experiments showed that practically all odor could be removed

from the garbage tankage drier gases by bubbling through a sufficient amount of water, but that water alone was not effective in removing the digester vent gas odors. When these gases were bubbled through a solution of sodium hypochlorite or of chloride of lime having a strength of 4 parts of available chlorine in 1,000 parts of water the odors were completely removed. Washing after preliminary incineration was effective, as the irritating sulphur dioxide fumes remaining after heating to 1,200° F. were completely removed by subsequent washing.

Oil Distilling and Refining Plants. — The fumes and odors from oil distilling and refining plants have caused very serious complaints in Massachusetts, Rhode Island and elsewhere.

Stephen deM. Gage has made a report upon extensive investigations of odors from these sources in Rhode Island (12), and he describes these odors as a mixture of hot, partly burned oil mingled with burning rubber, and a sweetish smell somewhat like purified naphtha, the combination being very disagreeable and producing in some people depression, nausea and a feeling of suffocation. Near the source, where intense, the characteristic sulphide odor of rotten eggs predominates; after a certain amount of dilution the predominating odor is like that of burning rubber; after further dilution the odor is like that on the opening of a baker's oven filled with well-browned bread, and with still greater dilution it is like that of scorching paper. These odors are said to be at times very irritating to the eyes, nose and throat, and at other times merely disagreeable to the smell. Mr. Gage states that these odors have been carried at least three or four miles. The actual areas found to have been affected by the two principal sources were fifteen and eight square miles, respectively, the comparative populations affected being 21,300 and 78,700, respectively.

Mr. Gage also calls attention to the magnitude of the odors from incomplete combustion of fuel oil rich in sulphur at power and heating plants, which in the aggregate appear to be a serious matter. These odors are essentially the same as those from petroleum distillation and refining plants, being due to oxides of sulphur, hydrogen sulphide and other sulphur compounds,

mixed with fumes of unburned or partly burned oil and forming a combination both irritating and malodorous.

The principal sources of odors from oil refining plants enumerated by Edward Wright, assistant engineer of the Massachusetts Department of Public Health, who has had much to do with the investigation in Massachusetts, are the flue gases, leaks from the still furnace walls, non-condensable gases escaping into the air from vents, especially in valves and in gas holders, stripping of stills, which is done by steaming out the gas or vapor after distillation, acid fumes from the acid treatment plant, gases from crude oil and its products, oil separators for liquids, filter house, wax pot and cooling of the coke.

Robert Spurr Weston (13) who has been advising certain refineries in the matter of odor elimination, states that the most successful plants have either put all refining apparatus, including tanks, under a vacuum system, and have passed all the gases through a fire, or have subjected them to treatment by washing with some of the raw material going through the process, that is, the counter-flow principle, as the washing of the gases with water simply transfers the odors to the water, which has at least as much tendency to give off gases as the oil.

Chemical Manufacturing Plants. — Odors from certain chemical manufacturing plants, including acid-making industries, copper smelting plants and zinc refining works, have been the source of much complaint, largely on account of fumes. Fumes from some chemical processes are not only objectionable in odor but are injurious to animal and vegetable life.

Professor Olin H. Landreth (14) cites the two most notorious plants of this character, — the Tennessee Copper Company and the Ducktown Sulphur, Copper and Iron Company at Ducktown, Tenn., near the Georgia boundary. Sulphur dioxide fumes from these two copper smelting plants destroyed all vegetation for miles, and caused serious injury to vegetable and animal life across the border of the state. Finally the United States Supreme Court restricted the output of these plants from April to October to an amount which would permit of the utilization of all of the sulphur dioxide gas in the manufacture of sulphuric acid, limited the amount of sulphur dioxide which

could be discharged into the atmosphere during the remainder of the year, and provided that continuous compensation should be made for damage done.

Mr. Tribus (6) cites the case of corrosive gases and offensive odors from manufacturing plants at Bayonne, N. J., one of the most noteworthy steps in eliminating the trouble being the collection and discharge of most of the gases through two great chimneys at a height of 360 feet or more above the ground, whereby diffusion and perhaps transformation is effective, unless a strong wind blows them earthward before such diffusion can take place.

Mr. Tribus also cites the case of the peculiar and irritating gases from various plants manufacturing foods, chemicals and other products, in Edgewater N. J., on the west bank of the Hudson River, opposite West 80th to 110th streets, New York City. These odors and gases were carried across the Hudson River canyon, which is about a mile wide, and caused serious discomfort to residents along Riverside Drive and in certain parks until effective methods of odor elimination were adopted.

Packing Houses and Allied Industries. —Odors from abattoirs or packing houses and allied industries, including stockyards, fertilizer works and soap factories, have given rise to serious complaints in numerous instances. In October, 1921, the writer was called upon to make an investigation and report upon the problem of elimination of odors from the stockyards, three large packing houses, a fertilizer works and a soap factory in Toronto, Canada. The following information is taken from the report.

When the abattoirs were first established in West Toronto years ago this section was sparsely populated and had not become a part of the city of Toronto. Since that time the section has been developed to a large extent, and now includes some of the most attractive residential districts of the city. With the growth of the packing house industry and the increasing population in the vicinity, it was natural that there should be an increasing number of complaints of odors, as packing houses and the related industries of stockyards, fertilizer works and soap factories are subject to the production of odors.

It appears that in 1915 or 1916 a case was brought against the Swift Canadian Company, Ltd., on account of objectionable odors. No verdict was rendered as it could not be proven that this company was solely responsible for these odors. A case was then brought against all three packing houses jointly. On account of war conditions and the fact that this was held to be an essential industry the case was dropped. In order to undertake the elimination of odors these concerns formed the West Toronto Sanitary Inspection Association, which proceeded with investigations to determine the sources of odors, and adopted various means of odor elimination. In 1921 a case against Swift Canadian Company, Ltd., was brought by the city department of health, in the Police Court before Magistrate Cohen, who, when he was assured by the writer that the packing houses were actively at work upon the elimination of odors, refused to order a conviction.

There are two main sources of odors: first, overhead odors transmitted by wind currents, and second, sewer odors from perforated manhole covers on the trunk sewer of the district. The former are due to dust, vapors and gases passing into the air, and the latter to vapors and gases given off from the liquids discharged into the sewers.

Stock Yards. — The source of odors from stock yards is very largely the solid and liquid excreta from the animals; that from hogs is particularly offensive. If the manure is allowed to remain in a wet condition the odors are much more pronounced, and the longer such manure is permitted to accumulate the more offensive it becomes, particularly in warm weather.

The odors come not only from pens in which the animals are kept, but also from the cars in which they are shipped. The offensive odor from these cars is familiar to all who have been in proximity to cars of animals in transit.

Fermenting grain mash left too long in feeding troughs or spilled upon floors is another source of odor, but this is only a minor one.

The odors contributed to sewers by stock yards come very largely from the solid and liquid animal excreta drained or washed into the sewers. The washing of hog pens is one of the chief sources. There is also the surface wash from the alleys and open

pens draining into the sewer system. The washing of feed troughs is a minor source of odor, due to fermentation of the grain.

The extent of these sewer odors is less the more frequently the pens are cleaned and the more efficient are the gratings and catch basins on the drainage system in retaining solid matters. If deposits of these solids occur in the sewers the odors will be increased.

For elimination of odors from the Toronto stock yards the recommendations included cleaning of the animal cars promptly after unloading; more frequent and more thorough cleaning of the receiving pens, which should be paved preferably with concrete; more frequent washing of the troughs and floors of the hog pens, and more frequent cleaning of the sumps; providing more liquid-absorbing material, such as sawdust or straw; and frequent removal of the manure and absorbent, thus keeping the pens dry and clean; handling all manure promptly and in a dry condition, using closed carts, if necessary; and making adequate provision for keeping manure out of the drains.

Abattoirs. — The odors from abattoirs are due very largely to the gases resulting from bacterial decomposition of animal matter. As soon as the life process is stopped decomposition begins, unless the substances are sterilized or placed in cold storage, where the temperature is too low for bacterial action. If animal matter is left lying about it will very soon create offensive odors.

The edible products go into cold storage very promptly and the odors consequently come very largely from the handling of inedible substances for by-products.

There are some odors on the offal floors, but if the offal is handled promptly these odors are not very objectionable.

The manure from the paunches has a bad odor, but after the liquid has been removed by manure expellers it is comparatively inoffensive; however, on handling after it has been allowed to stand and heat, the manure odor may be very strong.

Some odors are created in the beef casing and tripe rooms, but under proper conditions these are only minor sources.

The hog casing room is a source of offensive odor, due to the process of decomposition of the tough outer skin to facilitate

its removal. By this process the casings, after running, are allowed to stand over night in barrels containing warm water. When the barrels are emptied the odor is very pronounced, and also during the subsequent machining and washing processes. The gauging process which follows is practically free from this odor.

The hide cellar, where the hides are packed and salted for about a month prior to shipment to the tanners, is subject to disagreeable odors unless the hides are promptly salted and the floors kept clean.

The chief sources of odors at packing houses are the processes of rendering the offal, evaporation of the tank water and pressing and drying of the tankage.

During the process of rendering, both for edible lard and for inedible lard or tallow, which is generally done by heating with live steam under pressure, the vapors and gases given off are very offensive. When the tanks are opened up after cooking there is ordinarily no offensive odor. The oils drawn off for lard and for tallow ordinarily have only a greasy smell and if properly handled do not create any offensive odors.

The tank water when first drawn off to the storage vats generally has no offensive odor. If allowed to cool, the process of decomposition sets in very quickly, probably due to the presence of spores which have not been killed by the steaming process, and offensive odors are created. If the tank water is heated again after cooling, the offensive odors given off are very greatly increased. It has been found that tank water must be kept at a temperature above 150° F. to prevent rapid decomposition. Even at this temperature decomposition proceeds slowly and objectionable odors are likely to be given off if the tank water is not taken to the evaporators within twelve hours.

The vapors and gases given off from the evaporators are more or less offensive depending upon the character and condition of the tank water. The "stick" also gives off more or less odor, particularly when heated after being allowed to stand for some time, as is sometimes done before mixing with pressed tankage for drying.

The solid matter or tankage when first dumped from the rendering tanks generally has only the odors of cooked meats. Upon standing and cooling decomposition sets in, and the longer it stands the worse it smells, and the more objectionable the odors from the subsequent processes of pressing and drying.

The dust, vapors and gases from the driers, which are commonly steam-jacketed, are more or less offensive in odor, depending upon the character and condition of the tankage being dried. The dried tankage is comparatively inoffensive except while it is being handled and dust is arising from it.

The blood, which is cooked promptly in open kettles, creates only a cooking odor when dumped promptly after cooking. The steamy vapors which arise have a decided odor of cooked meat but this can hardly be called offensive. If the cooked blood is allowed to stand it is subject to decomposition and the production of foul odors. The dried blood is not particularly objectionable in odor.

The general statements with reference to tankage and dried blood apply to hog hair when it is disposed of by cooking in the rendering tanks for utilization as fertilizer. When prepared for the market by washing, which is done in a pecking machine, and drying, which is done on steam-heated screens, a somewhat objectionable odor is given off, particularly during the drying process.

The bones if allowed to stand in a warm place with more or less flesh attached to them will become offensive in odor. If cooked promptly the vapors given off have only the odor of cooking meat, and if washed and dried promptly no further odor is created.

The process of rendering fat and bones in the manufacture of "cracklings" is attended by more or less odor, depending upon the character and condition of the raw materials.

If shop fat is brought in from the outside for rendering, handling of the material and washing of the barrels or other containers will give rise to more or less objectionable odor, depending upon the amount, character and age of the material handled.

The process of deodorizing cotton seed oil used in the manufacture of oleomargarine, if exhausted into the air produces a characteristic burning oil odor which would be classed as objectionable although not offensive.

At packing houses, as at most industrial plants, refuse accumulates here and there, much of it combustible. If this is burned in the open the smoke will have a more or less objectionable odor, depending upon the nature of the materials burned. If these include old rubber boots, dirty worn-out press cloths, oily rags, animal matter and the like, the smoke will be correspondingly objectionable and the extent of odor produced will depend upon the amount of such materials burned.

The odors contributed to the sewers by the packing houses come from the various wash waters and other wastes from the various processes, the kind and extent of odor depending upon the processes, and the promptness of completeness with which the solid matters are removed from these waters before they are discharged into the sewer system. The extent of dilution is also an important factor. Other things being equal the more concentrated these wastes are the greater will be the extent of objectionable odors.

Wash water from fresh offal is not very objectionable. The wash water from the hashing of hog and sheep guts and the liquid removed from paunch manure by expellers, and drainage from manure carts and cars, have a characteristic manure odor, but if the manure is separated from the water promptly, the odor of the water will not be very strong.

The vapors from hog scalding water are somewhat objectionable in odor, and the heating effect on other wastes with which it is mixed tends to increase the odors given off on account of both vapors produced and increased speed of decomposition of organic matter at warm temperatures. This effect is produced by any hot water discharged into the sewers.

One of the most malodorous waste waters is that from the hog casing department, caused by the process of fermentation previously described.

Tank water if discharged into the sewers instead of evaporating it may be a serious source of offensive odor. When cooled

to the normal temperature of sewage it decomposes rapidly, with the production of foul odors. The settlings from tank water when discharged into the sewers are particularly objectionable unless treated in some way.

Condenser waters from the exhaust of the rendering tanks, from the tank water evaporators, and from the dryers have a very bad odor.

When the vapors from the cotton-seed oil deodorizing process are condensed the condenser waters have a disagreeable burning oil smell previously referred to, and this is a very persisting odor and one which tends to disguise other odors in the sewers.

The waters from the washing of vats and floors are more or less objectionable in odor, depending upon the character and condition of the solids and liquids which have been stored in the vats or spilled upon the floors.

The odors from the different waste waters when mixed may lose some of their characteristic smells, one kind being neutralized by another, or destroyed as a result of actual chemical action. On the other hand, the mixing of the liquids may produce worse odors or render characteristic odors more objectionable; for example, the odor of cotton-seed oil condenser water, although disguising other worse odors, itself becomes more objectionable in character.

As previously stated, the longer the putrescible solid matters are allowed to remain in contact with the waste waters the greater will be the odors from the sewers. The effectiveness with which solids are removed by screens and catch basins is also a very important factor. If solids capable of settling in the sewers are discharged therein, the resulting deposits may give rise to very objectionable odors, due to decomposition or putrefaction.

The packing houses at Toronto had already made great progress in the elimination of odors when the writer made his investigation.

The vapors and gases from the rendering tanks were being drawn from the tanks by a vacuum system and discharged into a hot well, from which the non-condensable gases were conducted

to the boiler furnaces. The vapors and gases from the driers were being exhausted into baffled dust boxes, and the gases, together with more or less air from other sources, discharged into washing and aerating towers and conducted thence to the boiler furnaces. The condensate from the vapors from both rendering tanks and driers was pumped to the top of the aerating tower and together with more or less water passed down through the tower, removing dust and condensible gases from the drier discharge.

Ventilation and air deodorizing systems were installed, drawing air from rooms subject to objectionable odors, such as those in the tank house and fertilizer building, and discharging it through boxes or towers on the roofs, provided with steaming pots or boxes of deodorant, such as pyrol and westopine.

These deodorizing pots were also distributed through the plants where odors were most likely to be created. These deodorants, as well as chloride of lime, were in some cases applied to substances such as tankage, which had developed odors. Particular attention was being paid to keeping rooms clean, washing floors, etc.

Some of the more objectionable liquid wastes, including the condensate and wash waters from the tower, and wastes from the hog casing room, were being treated with pyrol, westopine, chloride of lime or caustic soda solution. The liquid wastes at each plant were being conducted to a general catch basin, where solids were being removed partly as deposits and partly as scum, and in some cases mechanical screens were also provided.

In spite of all these precautions and devices offensive odors were being produced at times, due partly to leaks from odor pipe systems, partly to failure to collect all odorous air in the ventilation and deodorizing systems, partly to inefficiency of deodorizing systems and deodorants, and partly to breakdowns and improper operation.

The recommendations included more prompt handling of materials subject to putrefaction; more frequent and more complete cleaning of kettles, tanks, catch basins, etc.; incineration of rubbish; improvements in ventilation and deodorizing

systems, and taking care of the air in certain other rooms by such systems; changes in washing and aerating tower systems; and numerous other changes in construction and in methods of operation, to make the odor elimination devices more effective.

Fertilizer Works. — If the manufacture of fertilizers is confined to the grinding and mixing of dry materials, such as tank-age, dried blood, dried bones and the like, the objectionable odors will be due to the dust which may be carried considerable distances. If acid phosphate is manufactured there will also be acid fumes to contend with. The trouble from this source will be due not only to the odors but also to irritation of the mucous membranes.

Works manufacturing fertilizers from dried digester tank-age, dried blood, phosphate rock and other fertilizing materials have no liquid wastes unless the dusts and fumes are washed by water sprays. Such wash waters generally have very little odor.

At one of the plants at Toronto acid phosphate was being manufactured; ground phosphate rock being mixed with sulphuric acid, which produces strong acid fumes. These fumes are collected and discharged through a scrubbing tower system equipped with water sprays and the wash water is passed through a catch basin to retain the dust deposits. This plant was found to be out of repair and not properly taken care of. Improvements in construction and in operation were recommended.

Soap Works. — The objectionable odors from soap works come partly from the steaming out of barrels and tank cars containing the grease or tallow, the objectionable nature of the odor depending upon the character and condition of the tallow used. The so-called country tallow is likely to be very objectionable in odor while that from modern packing houses is comparatively inoffensive. The vapors from keeping the oil hot and from boiling in the first stages of soap manufacture will be more or less objectionable, depending upon the character of the raw product and the promptness with which it is handled.

At soap works the only objectionable odors contributed to the sewers are from the wash-up waters, where rancid oil or other foul-smelling substances have accumulated. At some

works no openings to the sewers are permitted for anything but cooling or condenser waters so as to avoid possible loss of valuable matter which might otherwise be washed into the sewers.

At the soap factory in Toronto inspection showed that the odor problem was not a serious one. Nothing more than ventilation and air dilution appeared to be necessary.

Tallow and Chicken Feed Plant. — The writer is now engaged in advising certain clients manufacturing tallow and chicken feed with respect to odor elimination in connection with a litigation case. The raw products are the bones and trimmings from butcher shops, which are ground and cooked in steam-jacketed kettles, producing tallow which is drawn off to metal tanks, and cooked material which is pressed into cakes called "cracklings" and dried and ground for chicken feed.

The company has installed a suction pipe system for the cookers, and a ventilation system, both of which discharge the gases under the fires of an oil-burning boiler. Apparently no offensive odors now pass away from this plant, but there is in the neighborhood at times a distinct odor of cooking or cooked fresh meat. The question of whether this is an offensive odor will probably be debated, but the writer is of the opinion that it cannot be classed as an offensive odor.

INVESTIGATIONS AND TESTS NECESSARY IN PROBLEM OF ODOR ELIMINATION

The field of odor elimination is relatively new, but much investigational work in this field has already been done. Reference has been made in this paper to a number of investigations along this line. There are others which have not been referred to. Among these should be mentioned the work of the late Rudolph Hering, D. Sc. (15), in the field of refuse disposal, in which he was an acknowledged expert and authority.

There is need of further scientific study and research on the subject of odors to obtain additional information relative to their nature and properties. It is important to devise scientific means of measuring the quality, quantity and carrying power of odors. In this connection reference should be made to "The Investigation of Stenches and Odors", by V. C. Allison

and S. H. Katz, of the Bureau of Mines (16), in which, by the use of an "odorometer" the intensity of twenty-four stenchs were studied, primarily with reference to their use as a warning in mines.

There is need of determination of the methods of odor elimination adapted for different odors, and the classification of odors according to effective methods of odor elimination.

Like other fields of sanitary engineering, odor elimination requires knowledge of chemistry and bacteriology, as well as engineering. There is need of the development of specialists in this field. At the present time, for most problems of odor elimination it is necessary to make a thorough investigation in each specific case. As Mr. Gage has pointed out, the degree of nuisance is a function of four variables, — intensity, frequency, duration and number of people affected. After the field investigations have been made it is necessary to investigate the sources of the odors. Some of the more important investigations and tests needed are discussed below.

Study of Industrial Processes. — It is necessary to study each industrial process in order to determine all causes of odors and the improvements in construction or in operation necessary to effect a remedy. This involves following each step of the process, making general observations, examining samples of solids and liquids which may create odors, and testing the dust, vapors and gases given off and the air in the vicinity.

The samples of solids and liquids should be examined for odors not only at the time of collection but after standing under different conditions to determine the effect of time and of temperature on odor production. By such examinations and a study of operating conditions it will be possible to determine to what extent odors may be prevented by more prompt handling of materials, and more frequent and more thorough cleaning of tanks, kettles, catch basins, floors, etc. The assistance which may be rendered in this case by the use of deodorants, disinfectants or other chemicals should also be investigated.

The objectionable gases, vapors and dusts should be carefully examined and tests made to determine the best method of elimination of odors, whether by air dilution, treating with deo-

dorants, disinfectants or other chemicals, washing, burning or some other process. In this connection it is important to determine the volumes of the odorous gases to be handled. The composition, temperature, humidity and dust content are important factors. Gas analysis may be necessary only in case of special research.

The apparatus required and methods of making these tests will be discussed later.

Determination of Efficiency of Systems for Collection of Odors.

— Where attempts are being made to collect odors at the source for special treatment it will be necessary to determine the efficiency of vents, hoods, ducts, pipes and fans used for the purpose. This will involve tests of the velocity and direction of flow of air currents, and examination of samples of air in the vicinity to determine whether the drafts created by suction or by pressure are sufficient to carry away all of the odorous gases, vapors or dust, and to prevent backdrafts. Special attention must be given to the detection of leaks in the collection system.

These investigations and tests should point the way to such improvements in construction or in operation as may be necessary to make the system efficient in the collection of odors, and to prevent the escape of odors from the collection system.

Determination of Efficiency of Ventilation Systems. — The determination of the efficiency of ventilation systems in buildings or rooms where objectionable odors are created is an important matter.

The direction of air currents must be determined under actual operating conditions, and if the drafts are found to be outwards when doors or windows are opened, these must be closed or properly regulated, or the capacity of the outlet fans increased if necessary. The use of two sets of doors providing an adequate vestibule may be found advisable.

The completeness of circulation of fresh air throughout the rooms must be determined by air tests, and if "dead spots" or places where odors are not promptly removed are found, air inlets and outlets must be rearranged, enlarged or regulated, as required to ensure sufficiently frequent change in air throughout the rooms. Wall fans may be found desirable to accomplish this end.

The velocity of flow of air in ducts or other passageways for air should be determined and computations made to ascertain the period of air changes in the different rooms and the opening into the air ducts regulated to give the desired frequency of air change, having due regard to the relative amounts of odor produced in the different rooms. The outlet fan capacity must be adapted to accomplish the desired results.

Determination of Efficiency of Air Dilution. — It is important to ascertain whether the odors removed by ventilation systems are sufficiently diluted to assure their dissemination in the atmosphere without creating overhead odors. This may be done by observations and tests of the air as discharged at different times. The odors must be slight and without much carrying power to go unnoticed.

If the air dilution is found to be insufficient it will be necessary to determine by air dilution tests whether this can be accomplished satisfactorily by increasing the fan capacity. If not, it will be necessary either to collect more odors at the source for separate treatment or to treat the air by some other method of odor elimination. The best method to adopt may be determined by tests.

If treatment other than air dilution is required, it may be advisable to draw from the rooms no more air than necessary for adequate ventilation. It may be found advantageous, however, to use air dilution in combination with some other method of odor elimination.

Determination of Efficiency of Deodorizing Systems. — In connection with systems where deodorants, disinfectants or other chemicals are used to overcome the objectionable odors from collected air, gases or vapors, it is important to determine, first, whether adequate mixing is being accomplished at all times. This can be done by examination of samples of the treated air or gases from different parts of the system. If the mixing is inadequate such improvements must be made in the application of deodorants or in the mixing devices as may be found necessary.

When satisfactory mixing is assured it is necessary to determine whether the objectionable odors are being effectively overcome. This can also be done by collecting samples of the treated

air or gases for examination. If too little or more than necessary of the deodorant is being used, changes must be made accordingly.

If the particular deodorant in use is found ineffective, other deodorants should be tried. In any case it will be advisable to test different deodorants in order to determine which is effective at least cost.

The cost of effective deodorizing should be determined and compared with the cost of other methods of odor elimination and a change made in the method if it is found advantageous to do so.

Determination of Efficiency of Incineration. — In cases where the odorous air or gases are being treated by incineration it will be important to determine whether the temperature afforded is sufficient for complete combustion of the odorous particles, and whether the air or gases are introduced in such a way and at such a rate as to be effectively heated to the required temperature for a sufficient period of time to accomplish the desired results. This may involve taking the temperature of the boiler furnace and the collection and examination of the flue gases, as well as observations and tests of the outside air in line with the smoke from the stack.

If it is found that obnoxious fumes are produced incident to the burning process in such amounts as to be objectionable, some method of odor elimination other than burning will have to be substituted or added. The best method may be determined by treatment tests.

If the temperature is found to be too low for complete combustion provision must be made for a higher temperature, or for some other method of odor elimination which may be found most advantageous by treatment tests.

If it is found that the boiler furnaces have insufficient capacity for utilizing the odorous air as forced draft, the volume to be treated by burning must be reduced, additional incinerator capacity afforded, or some auxiliary method of odor elimination adopted as may be found most advantageous.

It will be advisable to ascertain to what extent the gases being treated are corrosive and what treatment, if any, is required before admitting them to the boiler furnaces. In this connection it will be important to find out whether it is satisfactory to

discharge vapors as collected directly into the boiler pit or whether they should first be condensed. The condensate is likely to have an offensive odor so that it is desirable to discharge the uncondensed vapors directly into the furnace if it is found unobjectionable to do this.

Determination of Efficiency of Washing or Scrubbing Systems.

— The effectiveness of washing or scrubbing systems can be determined by observations and tests of the washed air or gases. If a system is found to be ineffective it should first be ascertained by laboratory tests whether it is practicable to remove the odors in this way. If so, water should be applied more effectively, a larger volume of water used, the velocity of flow of the air or gas reduced, or the scrubbing chambers or towers improved or enlarged, as may best meet the local situation.

If water alone is not effective the addition to the water of some chemical, such as chloride of lime or liquid chlorine, may be advisable.

Supplementary treatment of the washed air or gases by deodorants, disinfectants or other chemicals, as previously mentioned, may be found most advantageous.

If the particular washing system installed is found to be ineffective or expensive to operate, it may be found advisable to make improvements in it or to adopt some other system. Provision for removal of moisture and dust from the washed air or gases may be an important feature.

Efficiency of Dust Removal Equipment. — The adequacy of dust-removal systems can be ascertained by determining the amount of dust remaining in the treated air. The method of determination of dust will be referred to under "Apparatus and Methods."

Improvements in dust removal, if necessary, will have to be made along the lines previously discussed under "Dust Removal."

Efficiency of Means of Deodorizing Waste Waters. — The efficiency of means employed for deodorizing waste waters can be determined by collection of samples before and after treatment, and observing the effect upon the odors at the time of treatment and after standing for different periods and at different temperatures. The disinfecting action can be determined by the stability

test and the oxidizing action by determination of nitrogen in the forms of organic nitrogen, albuminoid ammonia, free ammonia, nitrites and nitrates. The effect of dilution of the treated wastes with clean water and of mixing the waste waters with sewage will also be necessary to arrive at the efficiency of the process. Different chemicals should be tried to determine which is effective at least cost.

A study should be made of the efficiency of screens and catch basins in the removal of solids from the waste waters; by observations and collection of samples for examination and tests. If these treatments are found to be inefficient it will be necessary to make such improvements in construction or in operation as may be most advantageous.

It will be important to determine whether the catch basins are being cleaned with sufficient frequency and thoroughness to maintain the waste waters in as fresh condition as practicable. This will likewise involve the collection of samples of influent and effluent for examination and tests.

If in spite of efficient screens and catch basins and satisfactory methods of operation, the combined effluent is still subject to the production of foul odors, it will be necessary to provide for the deodorizing or the disinfecting of this effluent, or further treatment of the particular waste waters which cause the odors. These points may be determined by tests.

It will be important to make a thorough examination of the sewerage system to ascertain whether deposits are being formed therein and the origin of and reason for these deposits — whether inefficient treatment or unreasonably low velocities of flow afforded at different times by the sewers. The velocity may be computed from the size and slope of the sewer and depth of flow, or determined by float tests.

If, after all that is practicable has been done to eliminate sewer odors due to the waste waters, objectionable odors still persist, the manhole covers should be made tight as far as practicable, at least those which are a source of complaint.

Apparatus and Methods. — The apparatus required and methods of making the investigations and tests will be more or less familiar to any sanitary engineer or sanitary chemist. It

may be helpful, however, to indicate in a general way what the more important apparatus and methods are.

In ventilation studies for the determination of moderate velocities of air currents the Pitot tube is the most accurate means. This instrument and its use are described in the "Report of a Committee on Standardization of the Use of Pitot Tube" (17), published by the American Society of Heating and Ventilating Engineers. In case of high velocities the vane wheel anemometer is generally used. The method of procedure and precautions necessary are discussed in the report of the Committee of the American Public Health Association on "Standard Methods for Examination of Air" (18). For very low velocities of air currents the Chicago Commission of Ventilation has suggested the use of visible fumes, toy balloons and aluminum pin wheels, as described in the above-mentioned report.

The samples of air or gases for examination and tests may be collected in suitable bottles connected to an aspirator bottle, from which water is drawn to cause the air or gases to flow into the sample bottle displacing the water, and thus obtaining a fair sample. The samples should preferably be examined in a room remote from odors.

The odors from gases or air can generally be intensified and differences brought out strongly by drawing the air or gases through water in measured amounts and at definite rates, and then examining the water. This can be done by suitable wash bottles connected with an aspirator bottle.

One of the most convenient forms of apparatus for this purpose is that known as the Palmer Water Spray Apparatus, manufactured by Wallace & Tiernan Company, Inc., Newark, N. J. This apparatus was specified for the determination of dust by the American Public Health Association Committee on "Standard Methods for the Examination of Air" (18). It is therefore adapted for the determination of the efficiency of dust-removal equipment. The apparatus and its use are described in "American Journal of Public Health" (19).

The efficiency of washing in the removal of odors can be determined with similar apparatus by bubbling the air or gas through water at different rates and collecting it afterwards for

examination. The advantage of chloride of lime solution or other chemicals can be tried in the same apparatus.

The efficiency of deodorants can be determined in a similar manner by conducting the air or gas over a steaming deodorant, with provision for mixing and testing the mixture for odors.

The efficiency of air dilution can be studied by mixing measured volumes of clean air with measured volumes of the gases or odorous air and examining the mixtures. The proportion of atmospheric air present can be ascertained by oxygen determinations.

The efficiency of burning can be determined by conducting the air or gases through a combustion tube heated in a suitable furnace to definite temperatures and testing it afterwards for odors. For this test suitable thermometers and a pyrometer-couple with a temperature galvanometer will be required.

The amount of moisture in air or gas can be determined by passing it through calcium chloride tubes or bottles. The effect of removal of moisture can be determined by testing the air or gas before and after dehydration.

The effect of removing vapors by condensing and the character of the condensate can be determined by passing the air or gas containing the vapor through a water-cooled Liebig condenser into an aspirator bottle which will retain the condensate, and from which the air or gas will be drawn to a second aspirator bottle, the water displaced in each case being drawn off by a syphon tube. Observations and tests can then be made on the gas and on the condensate as desired.

If it is desired to analyze the gas or air, a Hempel apparatus may be used, as described in Hempel's "Gas Analysis." Sulphur compounds in the gases may be determined by tests with lead acetate paper, or by passing the gas through bromine water and adding barium chloride solution to precipitate the sulphate formed.

For sanitary analysis of the waste waters, including solids, the "Standard Methods" of the American Public Health Association, published in 1922, will serve as a guide.

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Discussion

JOHN P. WENTWORTH:* I am sure Mr. Fales will be glad to answer any questions you would like to ask.

Mr. Fales referred to the excellent work done by the Massachusetts Department of Public Health. Mr. Wright is here this evening; perhaps he will add something.

EDWARD WRIGHT:† Professor Whipple in discussing this subject of odor elimination before the American Society of Civil Engineers, following Mr. Tribus' paper, said that the engineering profession had not developed any specialists in this line. After listening to Mr. Fales I am inclined to take issue with Professor Whipple's remark.

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It might interest you to take up very briefly one of the legal phases of the oil odor situation in Massachusetts. As you know, after the war there was a great scramble to establish oil refineries in New England, and the construction of three large refineries was started in Massachusetts in the latter part of 1919. I might add that the construction work has never been finished, but during 1920 and 1921 about twelve million dollars were spent in the construction of these three refineries. The main source of crude oil then available was Mexico, and Mexican oil is very rich in sulphur, great quantities of which are eliminated in the distillation processes. The question of eliminating odors from these gases was new, because the refineries which had previously been operating on high sulphur oil were located either adjacent to fertilizer works or in isolated parts of Louisiana or Mexico, where people were more or less accustomed to offensive odors and paid no attention to them. In the refineries in Massachusetts provision was made in the beginning for burning the most objectionable odors in the air, and later, when the gas was found to have a heat value, gas holders were constructed and the gas stored and burned for fuel. Gas burners were developed when the gases were found to have a heat value, but no methods of determining pressures or of finding out how the gas holders were working from the point of view of the still operator were available; and the first great difficulty occurred one night when the water-seal in a large gas holder holding 250,000 cubic feet of the most offensive gas froze. There were no gages on the gas-line, and the man in the receiving house had no notion of any trouble until the top of the gas holder blew off. Practically the whole Metropolitan District very shortly knew of the difficulty. This started the ball rolling, resulting in a very extensive complaint to the State Department of Public Health.

The law provides that locations shall be assigned for rendering works, soap factories and other offensive trades by the local boards of health. It also provides that if such establishments become nuisances, the Department of Public Health may upon application, hear the parties interested, and may, if in its opinion the public health, comfort and convenience so require, order the industry to desist from the further carrying on of the business.

The hearing was held in February, 1921, and the largest hearing room in the State House was secured for it, but it was necessary to move over to Ford Hall to accommodate the people desiring to be heard. The hearing lasted two days, and on April 2, 1921, the Department served an order closing the works.

The company immediately appealed, and its representatives stated that they didn't know what to do about stopping the odor, but they were willing to do anything that seemed advisable. They hired numerous experts to try to relieve the situation, and the order was extended from time to time, but the situation was not relieved, and in the following March (1922) it was put in force again and the refinery was closed.

The statutes provide that a company can appeal from a closure order for a jury trial and that the jury can either annul, affirm or alter the order. The company appealed, and retained Ralph A. Stewart of Choate, Hall & Stewart for counsel. I am told that a large sum was appropriated to fight the case. Numerous preliminary conferences as to how to proceed with this case were held, and at one of these conferences some pictures were shown which had been taken of the gas holder, showing holes big enough to insert a finger. This picture seemed to make considerable impression on the company and its attorneys. The last case of this sort was tried in the 80s, and in that case the jury did not affirm or annul the order but altered it, requiring certain structural changes in the plant. The Attorney-General seemed to think that the best that could be accomplished was a verdict altering the order of the Department. Information came to the attention of the Department that the general public in the town referred to wanted to retain the industry. There was a fuel shortage, and it appeared very likely, therefore, that instead of expecting the jury to abolish this very expensive plant the order would be altered and plant changes ordered. The State was not sure that it was going to be possible to operate an oil refinery under Massachusetts conditions without complaint, especially in view of the fact that complaints were coming in regarding the other two refineries in the State, and it seemed advisable to consult with the leading oil refinery experts in the country and de-

termine whether it was possible to operate on high sulphur oils without creating a nuisance. Mr. Robert Spurr Weston was retained by the company, with Mr. Stewart, and we finally selected the superintendent of the Gulf Refineries, Mr. Charles B. Buerger, an engineer, and travelled to Pittsburgh to see him. Mr. Buerger assured us that it was possible to operate a refinery with the proper appliances, without making it an unwholesome neighbor, and thereupon a so-called "agreed verdict" was prepared with a great deal of care by the attorneys interested in this case.

The case came on to be heard in November, 1922, and the court papers show that the attorney for the company in his remarks to the jury admitted that the company had been an impossible neighbor, while the court in making its charge to the jury stated that the company had seen the error of its ways. The prepared verdict was presented to the jury, and in half an hour was returned intact and accepted by the court. Instead of consuming some six weeks or two months or more in a long, tedious trial, therefore, the case was settled in about two hours. The verdict provides that the company shall be permitted to carry on its operations after completing certain odor elimination work that was then under contract, costing about \$57,000 and that —

(5) The Company shall, before the resumption of its business of the distillation oils on its said premises, except as hereinafter provided, expend in addition to the expenditures called for by the four preceding paragraphs hereof:

(a) At least one hundred thousand dollars (\$100,000) for the purchase, construction and installation of machinery, equipment, devices and appliances to eliminate and prevent objectionable odors and the escape of oil from said premises; said machinery, equipment, devices and appliances to be subject in design, construction, materials, installation and every other respect to the approval of the said Department of Public Health (or its representative), and a representative to be selected by the said Company, and in case said representatives or said Department and said representative of the Company shall be unable to agree, then subject to the approval of such competent disinterested third party as the said representatives or said Department and said representative of the Company shall in writing appoint.

(b) Such part of fifty thousand dollars (\$50,000) in addition to the sum referred to in paragraph (5), subparagraph (a) hereof, for the purchase, construction and installation of machinery, equipment, devices and appliances to eliminate and prevent objectionable odors and the escape of oil

from said premises as may be determined to be reasonably necessary by the said Department of Public Health (or its representative) and a representative to be selected by the said Company, and in case they shall be unable to agree then such part of said last-named fifty thousand dollars (\$50,000) as shall be determined to be reasonably necessary by a competent disinterested third party appointed in writing by said representatives or by said Department and said representative of the Company. Any sums expended under paragraph (5), subparagraph (b) hereof, shall be for the purchase, construction and installation of machinery, equipment, devices and appliances to eliminate and prevent objectionable odors and the escape of oil from said premises, all of which shall be subject in design, construction, materials, installation and in every other respect to the approval of the said Department of Public Health (or its representative) and a representative to be selected by the said Company, and in case said representatives or said Department and said representative of the Company shall be unable to agree, then subject to the approval of such competent disinterested third party as the said representatives or said Department and said representative of the Company shall in writing appoint.

Said Company shall not resume its business of the distillation of oils or any part thereof on its said premises until everything required by paragraphs 1 to 5 inclusive hereof has been fully completed, except to such extent and for such period or periods of time as said Department of Public Health may from time to time specially authorize.

(6) All of the machinery, equipment, devices and appliances purchased, installed or constructed by the said Company in accordance with the provisions of the preceding paragraphs hereof shall thereafter be maintained and operated by it in an efficient and proper manner by competent officers, employees and servants of said Company and with a view of preventing and eliminating objectionable odors on and about said premises and the escape of oil from said premises.

(7) If the services of a disinterested third party are required to carry out any of the provisions of paragraph 5 hereof, his compensation and expenses, if any, shall be borne equally by said Company and said Department of Public Health.

(8) The permission hereby granted shall, subject to the restrictions and conditions hereby imposed, be construed to include the temporary receiver of said Company appointed by the Superior Court for Suffolk County November 1, 1922, any permanent receiver of said Company who may be hereafter appointed, any successor corporation of said Company and any successor to the right to occupy said premises.

(9) Nothing herein contained shall be construed as preventing said Department of Public Health from making such further orders in the premises under the provisions of Section 152, Chapter 111 of the General Laws of Massachusetts as in the judgment of the said Department the public health, comfort or convenience require.

About the time that this verdict was handed down, the company went into the hands of a receiver. Another organization has since purchased the refinery, has made certain improvements in plant and in methods of operation, and is operating the refinery under a special permit of the Department.

In connection with the odor elimination devices, at certain Massachusetts plants recording gages have been installed and records kept of the production of the offensive gases, so that when complaints come in it is possible to study the gage records and make a reliable determination of the particular cause of the complaint. This method has been of great assistance in correcting conditions in a number of instances.

I was very much interested in what Mr. Fales said about the manufacturer never thinking the odors emanating from his plant offensive. Some time ago I visited a fish fertilizer plant where tons and tons of fish are cooked for the removal of oil and the manufacture of fertilizer. The oil is kept under heat a considerable time before it is finally barrelled and sent away, and the odor is really inconceivable and beyond description. One of the operators at this plant in trying to assure me to the contrary took up a cup of the oil and proceeded to taste it.

ROBERT SPURR WESTON:* We have had such a good paper and the field has been covered so thoroughly, besides the hour is so late, I am still retained by an oil company and we have an official of the State Department of Health here, that I don't think I ought to prolong this discussion, but I am very much interested in all that Mr. Fales has said.

We ought to consider in the first place that odors are of two different kinds. We have the true odorous gases, like sulphur dioxide and hydrogen sulphide, and odors due to highly dispersed solid substances in air.

When considering the true gases we can apply the law of dilution, and because they diffuse rapidly, state that their intensity varies approximately inversely as the square of the distance from the point of origin. But when considering odors due to dispersed liquids or solids this law doesn't apply, for a droplet of dispersed fish oil or garbage distillate is about as appreciable at

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ten as it is at two miles away. On the other hand, suffocating concentrations of sulphur dioxide disappear a short distance away. The problem of odor control is therefore largely the problem of intercepting the droplets.

There are two classes of odors and two organs of smell, each with its independent nerve-endings. The first of these are true odors, like vanilla or musk; the second, are irritants, like sulphur dioxide or chlorine. Some substances — like tobacco smoke, mustard or pepper — are both odoriferous and irritating.

The odors are smelled by two little patches of nerve ends, each about 25 millimeters square. One of these patches is on each side of the septum between the nostrils, and extends over the vault between the septum and the upper turbinated bone and part way down the latter. This protected position explains why it is necessary to sniff to bring certain delicate odors to the attention, and why a cold or closed nostrils take away half the pleasure of eating, for it is true that the nose does most of the "tasting." Farther down in the nasal cavity are the nerve endings, which are sensitive to the irritants, as every sufferer from hay fever or every fireman knows.

We smell an odor or notice an irritant through little hair-like processes on the ends of the nerves in the nose. These hairs are surrounded by the mucous membrane, and the leading theory is that the odor is dissolved in the constantly changing mucous and makes its impression through this medium upon the nerves. This is physiology, not engineering, but an engineer has to know many sciences to control odors, and besides will meet the public upon more frank and intimate terms than in any other engineering work I know.

It is because certain odors exist as dispersed solids or liquids that the Cottrell process is much used to control the dust emitted by smelters and cement mills. This process is an electrical one, and by it practically all volatile substances which are held in suspension because of their electrical charges may be precipitated by neutralizing these charges.

In principle the apparatus consists of a tube through which the burdened air or gases are passed, and which has a wire strung along its long axis. The wire is charged with a positive current

of high voltage; the tube acts as the negative pole. The discharged suspended matter collects on the wall of the tube and is removed by tapping or otherwise.

The hardest work in odor control is to "catch" your odor. When caught and confined it is comparatively easy to scrub it out with water, destroy it with fire or deodorize it with chlorine.

Deodorization by chlorine, brought into prominence by the works of Professors Haggerty and Henderson of Yale, has been successful in garbage works, rendering works, and the like. Its use apparently oxidizes or otherwise changes the disagreeable compounds into agreeable ones. It is necessary to apply the chlorine in the presence of moisture, and the use of the combination is patented.

We experimented with chlorine at a refinery in southern Massachusetts, applying it to the gases from a furnace fired with fuel oil and the gases distilled from crude petroleum. We found that little chlorine was needed to mask the odors given off from oil-fired stacks and that the process was readily controlled. Fortunately for the neighbors of New England refineries, the supply of Mexican petroleum, which is high in sulphur and gives off a bad odor, is low; and the oils low in sulphur from California, which are being refined at present, give rise to little complaint.

It is a privilege to endorse Mr. Fales' statements as to the public health phase of the subject. As Professor Whipple said recently, "It is the promotion of health not the event of death which concerns us here." A person may suffer grievously without having a specific disease. Certain odors are certainly not health promoting even though a merciful God has arranged that our sense of smell may be fatigued to insensibility and a person live in their presence. Citizens have as much right to demand clean air as clean houses, clean streets and clean food, and it is certain that the movement toward it will grow and result in better living conditions.

RALPH W. HORNE.* I think Mr. Fales mentioned various methods of deodorizing air in buildings. I wonder what he thinks of ozone, — whether that method is well established and whether it is satisfactory?

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MR. FALES: I don't seem to know of any place where that is being carried out. Of course ozone is a strong oxidizing agent, and I should think it might well be considered a means of deodorizing. Whether it is an economical one I think is somewhat of a question. I should think probably treatment with chlorine would be a more effective and more economical method of oxidizing to prevent the odorous gases.

MR. WRIGHT: If I may answer Mr. Horne, — about ten or twelve years ago we tried out ozone in conjunction with the General Electric Company. Experiments of this apparatus were tried out in one of the most offensive rooms of the North Packing and Provision Company in Somerville, but it was found impossible to generate a sufficient amount of ozone to kill the odor and make it possible to breathe in the atmosphere safely. The apparatus did not prove successful in this instance nor was it found to be economical.

GORDON M. FAIR:* The St. Louis schools have been using ozone and have reported very excellent results in the deodorizing of recirculated air in their rooms by ozone. Of course in strong concentrations it is toxic, and it is a question whether the use of even small amounts is good.

MR. WENTWORTH: I might add that when Mr. Horne and I were pupils of Professor Spofford, Mr. Horne wrote a thesis on ozone. I am very much surprised that he should ask a question about it.

FRANK A. MARSTON:† Odors from chemical closets for human excreta have been masked by the use of creosote or phenol products, but in these cases the odor of the deodorant was in itself objectionable. Caustic soda has been used successfully and has very little odor. The material from the chemical closets has been poured over garbage in pits and then buried. In this way the garbage odor was killed and animals and flies were prevented from feeding on the garbage.

It is interesting to compare the short distance that odors from sewage sand filters travel, with the much longer distances, I think, that odors of roasting coffee travel as a rule. The odors from

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† Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

roasting coffee and from chocolate factories, while not ordinarily thought of perhaps as unpleasant, are in some cases considered to be particularly objectionable.

One becomes insensible to unpleasant odors through constant association with them. At Whiting, Ind., the odor from the oil refineries is so strong that a stranger tastes oil in everything he eats, but the residents are said not to notice it.

PROF. DWIGHT PORTER:* I'd like to ask a question relating to a minor point. I'd like to ask Mr. Wright whether his Department has heard of any neighborhood complaints hereabouts from odors escaping where houses are being heated by oil instead of coal. I live near Middlesex Fells where one would expect to have pure air, but we have been annoyed very considerably by oil-heating plants used by our neighbors, and I wondered whether that was a health matter.

MR. WRIGHT: I think perhaps the best answer I can give is to tell of an experience I have had at the Andover sewage filter beds. These sewage filter beds were not always maintained in the very best condition, and they have just been abandoned by building a sewer to take the sewage to the Merrimack River. Lately the Shawsheen Mills have started to burn oil under their boilers, and the fumes from their stack have at times been more pronounced than the odors from the filter beds.

One of the buildings back of our office burns oil for fuel, and now and then the fumes are offensive. There has been considerable agitation in Walpole and also in Brookline. It has decreased considerably, however, since the refiners have begun getting oil from California instead of from Mexico.

PROFESSOR PORTER: These people seem to use red oil.

MR. WRIGHT: I think that is coal oil or gas oil. It is not the usual fuel oil used for power purposes.

MR. WENTWORTH: Are there any further questions?

MR. WRIGHT: There is just one more thing I would like to say. It is of course true that in the management of sewage disposal works operation is as important a factor as the design and construction of the works, and it is equally so with odor elimination appliances. One oil refinery maintains a force of

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nine technically trained men constantly in watching the odor control apparatus. The force is kept at work day and night in seeing to it that the gages and other pieces of apparatus are working properly.

MR. WENTWORTH: How large a plant was that that requires nine men?

MR. WRIGHT: The output of the refinery is about 20,000 barrels a day.

ARTHUR L. GAMMAGE:* A short time ago some interesting experiments were conducted on a mixture of material like household refuse with sewage sludge. In this process enough gas was recovered to furnish the heat necessary for conducting the process. There were practically no odors evolved from the distillation process, a large part of the organic matter and almost all of the oil decomposing going to gas, which was recovered in the process.

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MEMOIR OF DECEASED MEMBER

FRANK WELLINGTON HODGDON*

FRANK WELLINGTON HODGDON, son of Dr. Richard Lord and Maria Wellington Hodgdon, was born on January 12, 1856, at West Cambridge, now a part of Arlington, Mass., in the family homestead now standing at the corner of Wellington and Pleasant streets.

He received his early education in the Arlington schools and later graduated from the Massachusetts Institute of Technology in the year 1876, receiving the degree of Bachelor of Science in Civil Engineering.

The whole of Mr. Hodgdon's career, covering a period of forty-seven years, was devoted to the service of the Commonwealth of Massachusetts as engineer of successive boards and commissions, beginning with the Board of Harbor Commissioners in 1876 and continuing with changes in name and organization to the present Massachusetts Department of Public Works, whose functions have been the development of the harbors and rivers and the custody of certain public lands of the Commonwealth.

The first appointment as Engineer of the Board of Harbor Commissioners covered a period of two years, from 1876 to 1878, largely on the reclamation of the Commonwealth flats at South Boston. In June, 1878, he became Chief Engineer of the Massachusetts Board of Land Commissioners, having charge of the surveys and construction of the sea wall and filling easterly of the entrance to Fort Point Channel, which is now the property of the New York, New Haven & Hartford Railroad Company in South Boston.

The creation of the Board of Harbor and Land Commissioners in 1879, a consolidation of the Board of Harbor Commis-

* Memoir prepared by Charles T. Main and William F. Williams.

sioners and other agencies, offered another opportunity to Mr. Hodgdon in an appointment as Assistant Engineer in charge of all engineering and field work connected with that Board. The functions or duties of this Board were increased by legislative enactments from time to time to include jurisdiction over the Connecticut River, portions of the Merrimack River and the great ponds belonging to the Commonwealth. The surveying and partition of the Back Bay lands reclaimed by the Commonwealth was done under Mr. Hodgdon's direction.

In 1892 and continuing until 1912 Mr. Hodgdon, as Chief Engineer of the Board of Harbor and Land Commissioners, had charge of all the harbor and waterway improvements and developments of the Commonwealth undertaken by this Board. During that period, in 1910, Mr. Hodgdon designed the Commonwealth Pier No. 6, a solid fill pier, with granite walls 44 feet high, to retain the filling, 1,200 feet long and 300 feet wide, construction of which was completed in 1912. The buildings on the pier were erected by the Boston Fish Market Corporation, which leased the pier from the Commonwealth.

An act of the Legislature of 1911 created the Directors of the Port of Boston, a Board whose duties were the improvement and development of the Port of Boston, including the operation as well as the construction of piers and docks, and to provide terminal facilities in Boston Harbor. In January, 1912, Mr. Hodgdon was appointed Chief Engineer of the Directors. The immediate work of the Directors was the reconstruction and completion of the Commonwealth Pier, No. 5 by the addition of a steel and concrete two-story building covering nearly the whole pier, which is 1,200 feet long and 400 feet wide. This pier is one of the best equipped for freight and passenger accommodations in the United States. There are six railroad tracks serving the first floor of the pier, and these are connected with the Commonwealth railroad yard, with capacity of 500 cars. Vehicular traffic enters the first floor by entrances from Northern Avenue and the second floor by a viaduct from Summer Street. The berths of the pier are dredged to a depth of 40 feet at mean low water.

Plans and specifications for the construction of the Commonwealth Dry Dock, the second largest dry dock in the world, were

completed in 1914. This dock, having a foundation on ledge rock, was built of concrete masonry faced with granite. The over-all length is 1,200 feet, with a minimum width at the entrance of 120 feet and a depth of 35 feet over the sill at mean low water. The dock is equipped with approach piers, floating steel caisson, pumping plant, capstans and other appurtenances. An intermediate sill was constructed so that vessels up to 550 feet in length may be docked without unwatering the whole dock. This dock, built under the direction of Mr. Hodgdon, was commenced in 1915 and completed in 1919, under the administration of the Commission on Waterways and Public Lands.

Commonwealth Pier No. 1, at East Boston, was constructed on the location of the former Eastern Railroad Terminal, having a length of 400 feet and a width of 150 feet, with a single story wooden shed and a depressed railroad track in the center of the pier.

Reclamation of the Commonwealth flats by the hydraulic method east of Jeffries Point has followed the lines recommended by Mr. Hodgdon, and the area covered up to 1923 was about 120 acres.

In 1919 Mr. Hodgdon was appointed Chief Engineer of the Division of Waterways and Public Lands, successors to the Commission on Waterways and Public Lands, and had charge of all harbor and waterway development throughout the State. Under his direction plane table sheets were made covering the entire water front of Boston Harbor, as well as many of the important rivers within the State. He made studies for the development of the Commonwealth lands at East Boston, including a projected layout for piers, docks and warehouses on the harbor front, with connecting streets, tracks and railroad yards.

He also supervised the layout and beginning of the construction of the Airplane Landing Field on the reclaimed lands at East Boston, as well as the railroad track extension to this new area from a connection with the yard of the Boston & Albany Railroad Company.

An engineering report published in March, 1921, relating to a traffic tunnel to connect Boston and East Boston, was one of Mr. Hodgdon's latest important reports. The investigations,

studies and report were made jointly by Mr. Hodgdon as Engineer of the Division of Waterways and Public Lands of the Department of Public Works and by Mr. Ernest R. Springer, Chief Engineer of the Transit Department of the city of Boston, these two departments comprising a Joint Board. A study of traffic conditions, the making of wash borings to determine the location, the investigation of ventilating equipment sufficient to exhaust the poisonous gases of combustion, and the study of several methods of financing the cost and operation were the bases for the report, which recommended two tubes, each with a capacity for two lines of traffic.

In addition to his regular duties connected with waterways and harbor development, his services were given to other State work. In 1897 he was appointed a member of the Commission of Topographical Survey and Map of Massachusetts to make town and city boundary surveys. This work was completed in 1915, after the Commission was discontinued and its duties transferred to the Board of Harbor and Land Commissioners.

In co-operation with officials of adjoining States he supervised the surveying and monumenting of State lines, having served as Special Commissioner on the line between the Commonwealth and the States of New Hampshire and Vermont.

In 1903 Mr. Hodgdon made a special report on the cost of improvements to Broad and Lechmere canals, required by the construction of the Charles River Dam between the cities of Boston and Cambridge.

The act incorporating the Boston, Cape Cod and New York Canal Company required that the Massachusetts Harbor and Land Commission approve the plans for the location and construction of the canal. Mr. Hodgdon, as Consulting Engineer, made an examination of the plans and in his report proposed some modifications. The same act directed the Board of Harbor and Land Commissioners and the Railroad Commission to be constituted as a Joint Board to supervise the construction of the canal. Mr. Hodgdon was appointed Chief Engineer of that Joint Board in September, 1909, and continued making reports on engineering questions and checking the character and amount of

work done until January 29, 1914, when he was succeeded by William F. Williams, M.Am., Soc. C. E.

In 1896-97 and in 1908 Mr. Hodgdon, jointly with the Engineer of the State Board of Health, made reports and estimates of costs of the improvements of Green Harbor, and was frequently consulted by that Board and its Engineer regarding various proposed river improvements.

Surveys and reports on estimated costs were made by him for the construction of a canal from Narragansett Bay through Taunton, Brockton, Weymouth and Fore River to Boston Harbor. The design was a ship canal of a uniform depth of 25 feet and a width of 130 feet on the bottom, with side slopes of 1 on 2 in earth, and 180 feet wide with vertical sides in rock, with 14 locks. The estimated cost was \$57,000,000.

As a Consulting Engineer, Mr. Hodgdon was held in high regard outside of the State, as is demonstrated by the fact that he was called upon by the Florida Coast Line Canal and Transportation Company to advise regarding the construction of the canal from St. Augustine to Key West, Fla.; also, in 1911, he was appointed by President Arosemena of Panama as a member of the Boundary Line Commission on the boundary arbitration between Costa Rica and Panama.

In 1912 the International Association of Navigation Congresses published a report on mechanical equipment of ports which Mr. Hodgdon presented at the meeting held at Philadelphia, Pa.

In his home town of Arlington, Mass., his advice was sought and freely given on important civic matters. For many years he was a member of the Water Department and Finance Committee of the town, and when the form of town government was changed he was elected to represent his precinct as its town meeting representative, which office he held at the time of his death. He was a sturdy and consistent citizen, always keeping in mind a definite end for the public good. He was also a stanch worker of the old Congregational Unitarian Church.

In the engineering profession he was held in high esteem, as evidenced by his service on the Board of government of the Boston Society of Civil Engineers and as President of the Society in 1906.

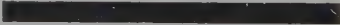
He also served as a director of the American Society of Civil Engineers from 1907 to 1909.

Other organizations to which Mr. Hodgdon belonged were the New England Water Works Association, Engineers Club, City Club of Boston, International Association of Navigation Congresses, Boston Chamber of Commerce, Real Estate Exchange, Arlington Historical Society, Middlesex Sportsman's Association, Unitarian Layman's League and the Arlington Men's Club.

He was a loyal supporter of his Alma Mater, faithful in attendance at all general meetings, and a member of the Massachusetts Institute of Technology Alumni Council, representing the class of 1876.

He chose to devote his efforts for the good of the Commonwealth and the community rather than to accept any of the offers of positions which would have brought large financial returns to him. The outstanding features of his life and work were steadiness and honesty of purpose and achievement and devotion to the task in hand.

He was devoted to his home and family. In October, 1886, he married Grace M. Plumer, the daughter of Captain William Plumer of Lexington, Mass., and is survived by his widow, two sons, Dr. F. Wellington Hodgdon, Public Health Commissioner of Pasadena, Calif., and Richard W. Hodgdon of Arlington, and a daughter, Mrs. Nancy Tuttle of Lawrence, Mass. He is also survived by a brother, Dr. Andrew H. Hodgdon of Dedham, Mass., and a sister, Miss Ellen Hodgdon of Arlington.



BOSTON SOCIETY OF CIVIL ENGINEERSFOUNDED 1848

PROCEEDINGS

ANNUAL REPORTS

Report of the Board of Government for the Year 1923-1924

BOSTON, March 19, 1924.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 19, 1924.

Membership

During the year 19 members have resigned, 26 have forfeited membership for non-payment of dues and 8 have died, making the total deductions 53.

Seventy-one members in all grades have been added during the year, of whom 6 were former members reinstated, and 6 juniors and 1 associate have been transferred to the grade of member.

The present membership of the Society consists of 7 honorary members, 798 members, 103 juniors, 24 associates, and 4 members of the Sanitary Section only, making a total membership of 936.

Deaths

The loss by death during the year has been 8, as follows:

William Dexter Bullock, April 30, 1923.
Rudolph Hering, May 30, 1923.
William Barnard Fuller, June 12, 1923.
Theodore Parker, June 14, 1923.
Hiram Allen Miller, November 2, 1923.
Charles Alfred May, December 21, 1923.
Walter Howard Sawyer, December 21, 1923.
Frederic Irving Winslow, February 21, 1924.

Remission of Dues

Under authority of By-Law 8, the Board of Government has remitted the dues of 3 members.

Exemption from Dues

Thirty-six members have been exempt from dues in accordance with the amendment to By-Law 8, which provides that "a member of any grade who has paid dues for 40 years, or who has reached the age of 70 years and has paid dues for 30 years, shall be exempt from further dues."

Regular Meetings

Seven regular meetings have been held during the year, and an inspection trip to the new Cambridge Filtration Plant which took the place of the regular meeting in June. An outing at Riverside, planned to follow the inspection trip, was given up owing to bad weather. The regular meeting in April was omitted on account of the meeting of the Affiliated Technical Societies of Boston on April 25, 1923, on "The Traffic and Operation of the Panama Canal," and the November meeting was omitted on account of a meeting of the Affiliation on November 26, 1923, on "Immigration as It Affects the Labor Situation."

The average attendance at the meetings of the Society was 155, the largest being 250 and the smallest 90.

At these meetings papers and addresses have been given, or special discussions held, as follows:

March 21, 1923. — Annual meeting. Address of the retiring President, Dugald C. Jackson, "Why is the Boston Society of Civil Engineers?"

May 16, 1923. — "The Manufacture of Genuine Wrought Iron Pipe," by A. A. Gatheman of the A. M. Byers Company, illustrated by moving pictures.

September 19, 1923. — "Apprenticeship in the Boston Building Trades," by Wm. Stanley Parker, President of the Boston Building Congress and President of the Commission on Apprenticeship; George T. Thornton, Second Vice-President of the Bricklayers, Masons and Plasterers International Union of America; Heywood S. French, of the J. W. Bishop Company; and James M. Gauld, Agent for the Carpenters' Union of Boston and Secretary of the Massachusetts State Council, United Brotherhood of Carpenters and Joiners of America.

October 17, 1923. — "Engineering and Construction Experiences," by Charles T. Main; William H. Sayward, Secretary of the Master Builders' Association; J. Parker Snow; William F. Williams, Commissioner of Public Works of Massachusetts; and James W. Rollins.

December 19, 1923. — "Hydro-Electric Development with Special Reference to the Hydraulic Equipment," by William Monroe White, Manager and Chief Engineer, Hydraulic Department, Allis-Chalmers Manufacturing Company, Milwaukee.

January 23, 1924. — Joint meeting with the Designers Section, B. S. C. E. "Fire Protection in Building Design," by E. A. Barrier, Vice-President and Engineer, Arkwright Mutual Fire Insurance Company, and John O. Taber, Chief, Boston Fire Department.

February 20, 1924. — Joint meeting with Northeastern University Section, B. S. C. E.; M. I. T. Student Chapter, American Society of Civil Engineers; Tufts Civil Engineering Society; and the Harvard Engineering Society. "The Treatment of Hudson River Water at Albany and Poughkeepsie, New York," by Allen Hazen, of the firm of Hazen & Whipple, New York.

Special Meeting

A special meeting was held on February 1, 1924, to consider the question of the proposed withdrawal of the Society from the Federated American Engineering Societies.

Sanitary Section Meetings

The Sanitary Section has held five meetings during the year, with an average attendance of 46. An inspection trip was made on June 6 to the new Water Purification Plant at Cambridge, Mass. The following papers have been presented:

March 7, 1923. — Annual Meeting. "Engineering and Public Health," by M. N. Baker, Associate Editor, Engineering News-Record.

October 3, 1923. — "Some Details of Boston Sewer Work," by Edgar S. Dorr, Engineer-in-charge of Special Work, Sewer Division, Public Works Department, Boston.

November 7, 1923. — "Measurement of Flow of Water by Salt Velocity Method," by Prof. Charles M. Allen, Worcester Polytechnic Institute.

December 5, 1923. — "Behavior and Methods of Control of Quicksand and Other Soils Met in Ordinary Excavation," by Col. Charles R. Gow, Consulting Engineer, Boston.

February 6, 1924. — "Elimination of Odors," by Almon L. Fales, of the firm of Metcalf & Eddy, Consulting Engineers, Boston.

Designers Section Meetings

The Designers Section has held seven regular meetings during the year, with an average attendance of 41. A joint meeting with the Society was held in January. The following papers have been presented:

March 14, 1923. — Annual Meeting. "Elements of Floating Dock Design," by J. Stuart Crandall, Treasurer, Crandall Engineering Company, East Boston, Mass.

April 12, 1923. — "Structural Details of Water Power Plants," by Howard M. Turner, Consulting Engineer, Boston.

May 9, 1923. — "Engineering Aspects of Geology," by William F. Jones, Assistant Professor of Structural Geology, Massachusetts Institute of Technology.

October 10, 1923. — "The Design of Textile Mills," by Kenneth Moller, of the firm of Lockwood, Greene & Co.

November 14, 1923. — "Unusual Features in the Design of New Ferry Slips for the City of Boston," by William W. Lewis, Assistant Engineer, Boston Transit Department.

December 12, 1923. — "The Design of an Ideal Shoe Factory Building," by John J. Gillespie, Head of the Industrial Engineering Division, Department of Agencies, United Shoe Machinery Corporation.

January 23, 1924. — Joint meeting with the Society. "Fire Protection in Building Design," by E. A. Barrier, Vice-President and Engineer, Arkwright Mutual Fire Insurance Company, and John O. Taber, Chief, Boston Fire Department.

February 13, 1924. — "The Design of Terminals and Warehousing Facilities," by Frederic H. Fay, of Fay, Spofford & Thorndike, Consulting Engineers, Boston.

Northeastern University Section Meetings

The Northeastern University Section has held five meetings during the year. The following papers have been presented:

March 28, 1923. — "Hydro-Electric Plants," by A. A. Northrop, of Stone & Webster, Inc., illustrated with moving pictures.

May 5, 1923. — Annual meeting. Address by the retiring Chairman, David C. Milne.

October 8, 1923. — "General Motions in the Construction of a Modern Building," by Frank M. Gunby, Engineering Manager for Charles T. Main, Engineer, Boston.

December 14, 1923. — "A Railroad Construction Job," by James W. Ingalls, Assistant Professor of Civil Engineering, Northeastern University.

February 1, 1924. — "Deep Foundations," by James W. Rollins, of Holbrook, Cabot & Rollins, Boston.

Permanent Fund

The Society again authorized the use of the income from the Permanent Fund in payment of current expenses.

The final installment of five hundred dollars has been received from the one thousand dollar bequest to the Society from the estate of Hiram F. Mills.

Tinkham Memorial Fund

This fund, the market value of which is \$2,333.16, has been given to the Massachusetts Institute of Technology for the establishment of the "Samuel E. Tinkham Fund," the income of which is to be used to assist some worthy student of high standing to continue his studies in civil engineering.

Journal

The report of the Editor of the JOURNAL for the calendar year 1923 shows that there have been printed ten issues, containing a total of 684 pages, the number of copies of each issue printed being 1,250. The net cost of the JOURNAL in 1923 was \$3,150.50, or \$4.61 per page. The net cost in 1922 was \$2,960.14, or \$5.29 per page. The cost per page has been the lowest since 1919, as a result of a more favorable scale of prices under a new printing contract made during the summer.

The Editor believes that an increased amount of advertising should be carried in the JOURNAL and has suggested to the Board the possible employment of an advertising agent to accomplish this.

Desmond FitzGerald Medal

In accordance with the report of the committee appointed to recommend the award of the Desmond FitzGerald Medal for the best paper, by a member of the Society, published during the year ending September, 1923, the Board has awarded the medal to Arthur T. Safford for his paper entitled "The Amoskeag Manufacturing Company Hydro-Electric Development," published in the March, 1923, JOURNAL.

Clemens Herschel Award

Clemens Herschel, an Honorary Member of the Society, has continued his gift of copies of his book entitled "The Two Books of Sextus Julius Frontinus on the Water Supply of the City of Rome, A.D., 97," with the request that the Board award one or more of these books each year as prizes for papers which have been particularly useful and commendable, and worthy of grateful acknowledgment.

The Board has voted to present at this time a copy of this book to John W. Raymond, Jr., for his paper on "Some Features of Sewer Design," published in the January, 1923, JOURNAL, and to J. Stuart Crandall for his paper on "Floating Dry Dock Design," published in the September, 1923, JOURNAL. These papers were presented before the Designers Section, of which both Mr. Raymond and Mr. Crandall are members.

Social Activities

The members of the Committee on Social Activities deserve special commendation for the success of the buffet suppers which have been held before the meetings during the past year. In addition to making arrangements for these suppers and for the smoker which follows this Annual Meeting, they have taken charge of the well-attended buffet suppers held in connection with the Affiliation meetings in April and November, 1923.

Society Activities

A noteworthy feature of the year has been the continued development of the Sections of the Society. The topics presented at these meetings have been of considerable interest, as indicated by the increased attendance this year. This Board has recommended to the incoming Board the establishment of prizes for papers of particular value, presented at Section meetings by members of the Section.

The attendance at the meetings of the Society has increased this year, and the buffet suppers before the evening meetings have proved most effective in broadening the acquaintanceship of the members.

In order to carry on the various activities it has been necessary to apply the income from the Permanent Fund to current expenses again this year.

Material improvements have already been made in the Library and more are now under way. These have been made possible by the generous subscriptions of a group of interested members, together with funds allotted by the Board. The report of the Library Committee contains full information on this subject.

Relations with Other Societies

After careful consideration, extending over a long period, the Board has recommended the withdrawal of the Society from membership in the Federated American Engineering Societies. A discussion of this subject was held at a

special meeting of the Society, and it was voted to submit the question to the membership by letter ballot. The result of this ballot, which is to be canvassed at the time of the Annual Meeting, will provide the incoming Board with the definite wishes of the Society in this matter.

The Affiliated Technical Societies of Boston, of which this Society is a member, has completed another year of service. Your Board feels that the results have been constructive and worthwhile to the engineering profession in this vicinity. As must be expected, various problems have arisen in connection with the operation of the Affiliation; these problems have to do principally with the adjusting of the amount of service rendered and the allocation of expense to the various member societies in accordance with the further experience during the past year.

In conclusion, the Board desires to express its appreciation of the loyalty and willingness of the officers of the Sections, and of the members of the different committees of the Society who have aided so materially in making this year one of progress.

For the Board of Government,

FRANK M. GUNBY, *President*.

Report of the Treasurer

BOSTON, March 1, 1924.

To the Boston Society of Civil Engineers:

Your Treasurer presents the following report for the year ending March 1, 1924.

Detailed data are contained in the appended tabular statements: Table 1 gives the receipts and expenditures for the year; Table 2, Comparative Balance Sheets; Table 3, Investment of the Permanent Fund.

The Current Expenses for the year amount to \$10,754.47, being \$106.57 increase over the preceding year.

There has been transferred to the Current Fund all the income of the Permanent Fund for the current year, \$2,490.39.

The net expense of the JOURNAL has been \$368.47 less than last year. The income from advertisements decreased \$126, and the sale of JOURNALS has been \$0.90 more than last year.

There has been received \$500 from the Hiram Mills Estate as a final payment of a thousand dollar legacy.

There has been an increase in the Permanent Fund of \$1,010 after transferring the income for the current year of \$2,490.39 to the Current Fund.

Respectfully submitted,

F. O. WHITNEY, *Treasurer*.

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TABLE 1. — RECEIPTS AND EXPENDITURES

CURRENT FUND

Receipts

Balance, March 1, 1923	\$6 96	
Members' dues	7,170 97	
Advertisements	899 00	
Sale of JOURNALS	221 35	
Sale of waste paper	9 04	
Library fines	10 42	
Income from Permanent Fund	2,490 39	
		\$10,808 13

Expenditures

JOURNAL:

Printing	\$3,167 07	
Incidentals	45 14	
Reprints	319 07	
Editor	320 00	
		\$3,851 28
Rent, meetings	185 00	
Salaries (except Editor)	389 50	
Printing, stationery, postage, etc., meetings	293 17	
Printing, stationery, postage, etc., office	505 97	
Incidentals, office	136 01	
Reporting, meetings	38 00	
Stereopticon, meetings	32 00	
Binding (net)	149 15	
Insurance	33 19	
Periodicals	145 55	
Annual meeting and smoker (net)	153 00	
Social activities (net)	363 72	
Federated American Engineering Societies	770 00	
Affiliated Technical Societies of Boston (net)	3,177 76	
Designers Section	30 53	
Sanitary Section	91 40	
Northeastern University Section	8 50	
Badges (net)	74	
Renovation of library	400 00	
		10,754 47
Balance, March 1, 1924		\$53 66

PERMANENT FUND

Receipts

Balance, March 1, 1923.	\$975 01
Entrance fees	510 00
Interest received (net)	1,952 49
Hiram Mills Estate (balance of legacy)	500 00
	\$3,937 50

Expenditures

Co-operative bank dues.	\$720 00
Income transferred to Current Fund	2,490 39
	\$3,210 39

Balance, March 1, 1924	\$727 11
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E. K. TURNER LIBRARY FUND

Receipts

Balance, March 1, 1923	\$89 49
Interest on bond	50 00
	\$139 49

Expenditures

Books purchased	\$81 79
Balance, March 1, 1924	\$57 70

TINKHAM MEMORIAL FUND

Receipts

Balance, March 1, 1923.	\$66 86
Subscriptions received	10 00
Interest on bonds	130 00
Interest on bank deposit	1 30
	\$208 16

Expenditures

Transferred to Massachusetts Institute of Technology	\$208 16
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SPECIAL LIBRARY FUND

Receipts

Subscriptions and appropriation	\$1,100 00
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Expenditures

Improvement of library	\$202 30
Balance, March 1, 1924	\$897 70

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TABLE 2.—COMPARATIVE BALANCE SHEETS

	March 1, 1921.	March 1, 1922.	March 1, 1923.	March 1, 1924.
Assets				
Cash	\$975 48	\$286 52	\$1,071 46	\$1,736 17
Bonds and notes . .	35,523 00	35,523 00	35,023 00	35,023 00
Stock	1,950 00	2,247 75	2,655 75	2,655 75
Co-operative banks .	8,159 45	7,737 85	8,877 50	10,135 40
Library	7,500 00	7,500 00	7,500 00	7,500 00
Furniture	2,405 11	2,405 11	2,405 11	2,405 11
	\$56,513 04	\$55,700 23	\$57,532 82	\$59,455 43
Liabilities				
Permanent Fund . .	\$44,682 51	\$45,432 51	\$46,537 51	\$47,547 51
E. K. Turner Fund .	1,097 12	1,083 02	1,083 24	1,051 45
Current Funds . . .	828 30	720 41*	6 96	53 66
Special Library Fund	—	—	—	897 70
Surplus	9,905 11	9,905 11	9,905 11	9,905 11
	\$56,513 04	\$55,700 23	\$57,532 82	\$59,455 43

* Deficit.

TABLE 3.—INVESTMENT OF PERMANENT FUND, MARCH 1, 1924

	Par Value.	Actual Cost.	Value as carried on Books.
Bonds			
American Tel. & Tel. Co. Col. Tr. 4%, 1929	\$3,000 00	\$2,328 75	\$2,737 50
Union Elec. Light & Power Co. 5%, 1932	2,000 00	2,050 00	2,050 00
Blackstone Valley Gas & Elec. Co. 5%, 1932	2,000 00	1,995 00	1,995 00
Dayton Gas Co. 5%, 1930	2,000 00	2,000 00	2,000 00
Milford & Uxbridge St. Ry. 7%, 1928	3,000 00	2,942 50	2,942 50
Railway & Light Securities Co. 5%, 1939	3,000 00	3,000 00	3,000 00
Superior Light & Power Co. 4%, 1931	4,000 00	3,347 50	3,347 50
Wheeling Electric Co. 5%, 1941 .	4,000 00	3,845 00	3,845 00
Economy Light & Power Co. 5%, 1956	1,000 00	990 00	990 00

TABLE 3. — INVESTMENT OF PERMANENT FUND, MARCH 1, 1924
— *Concluded.*

	Par Value.	Actual Cost.	Value as carried on Books.
Tampa Electric Co. 5%, 1933	\$2,000 00	\$2,000 00	\$2,000 00
Galveston, Houston Elec. Ry. Co. 5%, 1954	2,000 00	1,940 00	1,940 00
Northern Texas Elec. Co. 5%, 1940	2,000 00	1,932 50	1,932 50
Chicago & Northwestern Ry. 5%, 1987	1,000 00	1,102 50	1,102 50
Vermont Power & Mfg. Co. 5%, 1928	1,000 00	965 00	965 00
Am. Tel. & Tel. Co. 5%, 1946	1,000 00	993 75	993 75
United States Liberty Loan 3½%, 1947	2,000 00	2,000 00	2,000 00
American Tel. & Tel. Co. 6%, 1925	200 00	188 00	188 00
Stock	\$35,200 00	\$33,620 50	\$34,029 25
22 Shares Am. Tel. & Tel. Co.	2,200 00	2,655 75	2,655 75
Total securities	\$37,400 00	\$36,276 25	\$36,685 00
Co-operative Banks			
20 Shares Merchants Co-operative Bank including interest to March		\$2,706 90	
15 Shares Volunteer Co-operative Bank including interest to January		2,623 20	
25 Shares Watertown Co-operative Bank including interest to March		4,805 30	
			10,135 40
Total value of invested portion of Permanent Fund			\$46,820 40
Cash			727 11
Total value of Permanent Fund			\$47,547 51
E. K. Turner Fund			
American Tel. & Tel. Co. 5%, 1946	\$1,000 00	\$993 75	
Cash on hand		57 70	
			1,051 45
Total value of Permanent and E. K. Turner Funds			\$48,598 96

REPORT OF AUDITING COMMITTEE FOR YEAR 1923-24

MARCH 19, 1924.

We have examined the accounts of the Treasurer of the Boston Society of Civil Engineers and find the books correctly kept and the various expenditures of the past year supported by duly approved receipts.

The Treasurer has also accounted to us for the investments and cash on hand, as submitted by the above report.

FRANK A. MARSTON,
DANA M. WOOD,

*Auditing Committee of Directors of the
Boston Society of Civil Engineers.*

Report of the Secretary

BOSTON, March 19, 1924.

JOHN B. BABCOCK, Secretary, *in account with the* BOSTON SOCIETY OF CIVIL ENGINEERS, *Dr.*

For cash received during the year ending March 19, 1924:

From entrance fees, new members and transfers:

31 new members and associates at \$10 00 . . .	\$310 00
34 juniors at 5 00 . . .	170 00
6 juniors transferred to members at 5 00 . . .	30 00

Total from entrance fees	\$510 00
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From annual dues for 1923-24, including dues from

new members	\$6,993 97
From back dues	104 00
From dues for 1924-25	73 00

Total from dues	7,170 97
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From advertisements	899 00
From sale of JOURNALS and reprints	221 35
From Library fines	10 42
From sale of badges	130 50
From binding JOURNALS	39 00
From sale of waste paper	9 04
From Social Activities Committee (smokers)	239 40
From annual smoker (1923).	14 00
From contributions to Special Library Fund	700 00
From Affiliated Technical Societies of Boston, for expenses	101 12

\$10,044 80

The above amount has been paid to the Treasurer, whose receipts the Secretary holds.

BOSTON SOCIETY OF CIVIL ENGINEERS.

The appended table shows the budget items and the actual expenditures for the year.

JOHN B. BABCOCK, *Secretary*.

COMPARISON OF ESTIMATED AND ACTUAL EXPENDITURES, 1923-1924

<i>Office:</i>	Budget	Actual Expenditures	
Salaries (except editor)	\$400 00	\$389 50	
Insurance and treasurer's bond	50 00	33 19	
Stationery, printing and postage	350 00	305 97	
Year Books	200 00	200 00	
Incidentals	100 00	136 01	
Periodicals and binding	250 00	293 95	
Total			\$1,358 62
<i>Meetings:</i>			
Rent	\$250 00	\$185 00	
Stereopticon and reporting	125 00	70 00	
Printing and postage	325 00	293 17	
Social activities (net)	300 00	363 72	
Annual meeting, 1923 (net)	160 00	153 00	
Total			1,064 89
<i>Sections:</i>			
Sanitary	\$100 00	\$91 40	
Designers	100 00	30 53	
Northeastern University	50 00	8 50	
Total			250 00 130 43
<i>Journal:</i>			
Editor's salary and expenses	\$400 00	\$365 14	
Printing and postage	3,350 00	3,167 07	
Reprints	250 00	319 07	
Total			4,000 00 3,851 28
Dues to Affiliated Technical Societies of Boston		3,136 00	3,177 76
Dues to Federated American Engineering Societies		775 00	770 00
TOTAL			
		\$10,671 00	\$10,352 98

REPORT OF AUDITING COMMITTEE FOR YEAR 1923-24

BOSTON, March 19, 1924.

We have examined the records and accounts of the Secretary of the Boston Society of Civil Engineers and have satisfied ourselves that they are properly kept, and that the money received has been transferred to the Treasurer.

FRANK A. MARSTON,

DANA M. WOOD,

*Auditing Committee of Directors of the . . .
Boston Society of Civil Engineers.*

Report of the Editor

BOSTON, February 20, 1924.

To the Board of Government, Boston Society of Civil Engineers:

The Editor submits the following report for the calendar year 1923 (Volume X of the JOURNAL).

There have been published nineteen papers and discussions, seven reports of the activities of the Federated American Engineering Societies, and four memoirs of deceased members.

The ten issues of the JOURNAL contained a total of 684 pages; the number of copies printed was 1,250 of each issue. The net cost was \$3,150.50, or \$4.61 per page. This compares with a similar figure for 1922 of \$5.29 per page.

A comparison of costs for the JOURNAL covering a period of five years (1919 to 1923 inclusive) is shown in Table 1. It will be noted that the cost per page in 1923 is the lowest since 1919. This is due primarily to the fact that beginning with the September issue advantage was taken of a new printing agreement by which the prices were materially reduced. It is expected that these prices will result in a substantial saving in printing costs during the coming year.

Although the receipts from advertising were less than the previous year, owing to the slowness of payments in a few cases, the amount of advertising carried was about the same (between \$900 and \$1,000). It is believed that this amount should be increased by as much as 50 per cent, and that it might be well to employ an advertising agent in order to accomplish this.

The Committee on Publication and the Editor are studying the problem of making the JOURNAL increasingly useful to the members, particularly by securing additional papers of current interest, and it is hoped that progress can be made along these lines.

In Table 2 are given details of cost for Volume X of the JOURNAL for the calendar year 1923.

Respectfully submitted,

JOHN B. BABCOCK, *Editor*.

TABLE 1. — COMPARISON OF COSTS OF JOURNAL, 1919 TO 1923, INCLUSIVE

YEAR.	Vol.	Number of Pages.*	GROSS COST.†		NET COST.‡		Number of Cuts and Inserts.
			Total.	Per Page.	Total.	Per Page.	
1919	VI	682	\$3,726 06	\$5 46	\$2,154 40	\$3 16	56
1920	VII	625	4,332 17	6 93	2,944 95	4 71	45
1921	VIII	674	5,088 48	7 55	3,537 91	5 25	58
1922	IX	560	4,022 14	7 18	2,960 14	5 29	76
1923	X	684	4,162 45	6 09	3,150 50	4 61	86

* Includes Advertising Section and Annual Index.

† Gross cost includes editing, printing, mailing and reprints.

‡ Net cost equals gross cost less amounts received for advertising, subscription and sale of JOURNALS and reprints.

TABLE 2. — 1923 JOURNAL, VOLUME X

MONTH.	PAGES.			NUMBER.		COST.					
	Papers.	Pro-ceed-ings.	Adver-tising.	Inserts.	Cuts.	Composition and Printing.	Inserts and Cuts.	Reprints.	Wrapping, Mailing and Postage.	Editing.*	Copyright.
January	46	10	12	—	11	\$264 94	\$48 19	\$58 00			
February	48	8	12	—	14	250 57	87 57	—			
March	34	10	12	1	13	265 53	66 94	43 87			
April	58	28	12	—	—	415 93	—	16 00			
May	42	6	12	—	5	246 32	14 87	36 80			
June	46	6	12	—	—	256 73	—	47 20			
September	50	6	12	—	21	291 38	110 14	45 95			
October	56	6	12	1	19	243 35	97 77	72 00			
November	40	10	12	—	—	193 15	—	—			
December	34	20†	12	1	—	197 71	48 30	13 00			
Total	454	110	120†	3	83	\$2,625 61	\$473 78	\$332 82	\$322 60	\$397 64	\$10 00

* Includes \$37.64 incidental expense.

† Includes 12 pages of Annual Index.

‡ Includes advertising index and any other unpaid space.

Gross cost	\$4,162 45
Receipts from subscriptions, sale of JOURNALS and reprints	\$242 95
Receipts from advertising	769 00
Net cost	1,011 95
	\$3,150 50

Report of the Library Committee, 1923-24

BOSTON, March 19, 1924.

To the Boston Society of Civil Engineers:

The Librarian submits for the Library Committee the following report for the year 1923-24.

Since the last annual report 183 bound volumes and 85 pamphlets have been added to the library. We now have a library of about 10,200 bound volumes and 3,600 pamphlets.

During the year 249 books have been loaned and fines amounting to \$10.42 have been collected.

Your Committee has given much thought and study to the development of the library along lines which will increase its usefulness to the membership of this Society as well as to members of the other affiliated organizations.

It was expected when the Affiliation was formed that the upkeep of the library could be borne by that organization, but that has not proved possible as yet, and the expense of periodicals, binding and new books has been met by the Society. The Committee has worked, however, in close co-operation with a similar committee representing the Affiliation, with the constant aim to make the library more generally serviceable.

During the summer a considerable number of periodicals and transactions of societies were added, particularly along electrical, mechanical, heating and ventilating, and mining and metallurgical lines. At that time substantial rearrangements of the bound periodicals and transactions were made to allow for future growth.

A reference shelf was started containing the latest handbooks and special reference books dealing not only with civil engineering subjects but also covering practically all of the principal engineering fields, and it is expected that this feature can be developed materially during the coming year.

The problem of the general text and reference books has been a complicated one, due to the fact that sufficient funds had not been available in the past to keep up to date in civil engineering books, and owing to the need of developing the library along broader lines now that the library is open to members of the other affiliated societies.

A special committee was appointed by the Board of Government this year to solicit funds for the improvement of the library. As a result, the sum of \$700 has been contributed by a group of interested members, which, together with \$400 allotted by the Board, has provided the funds to make the needed improvements.

The books and shelves have been thoroughly vacuum cleaned this winter, and a start has been made in securing a considerable number of needed books. Those first purchased have been largely of a civil engineering character, although not entirely so. Studies are now under way to determine to what extent a broadening of the scope of the library should be considered in the purchase of new books.

The system of arranging and classifying the textbooks needs to be improved, and it is hoped that this can be done in the coming spring and summer.

After the library has been put in good condition it will be necessary to have the services of an additional library assistant, at least part time, in order to keep it up to date.

The principal books which have been added during the past year are shown on an appended list.

Respectfully submitted,

For the Library Committee,
JOHN B. BABCOCK, *Librarian*.

BOOKS ADDED TO THE LIBRARY, 1923-24

Handbooks

American Electricians' Handbook, Terrell Croft.
American Machinists' Handbook, Colvin & Stanley.
Handbook for Electrical Engineers, Pender.
Handbook for Heating and Ventilating Engineers, Hoffman.
Handbook of Steel Erection, Bland.
Highway Engineers' Handbook, Hubbard.
Mechanical Engineers' Handbook, Kent.
Mining Engineers' Handbook, Peele.
Standard Handbook for Electrical Engineers, Fowle.

Structural

Earth Pressure, Retaining Walls and Bins, Cain.
Engineering and Building Foundations, Fowler.
Foundations, Abutments and Footings, Hool & Kinne.
Movable and Long-Span Bridges, Hool & Kinne.*
Steel and Timber Structures, Hool & Kinne.*
Stresses in Framed Structures, Hool & Kinne.*
Structural Drafting, Bishop.
Structural Members and Connections, Hool & Kinne.
Suspension Bridges, Steinman.

Hydraulic, Hydro-Electric and Sanitary

Centrifugal Pumps, Daugherty.
Hydraulics, King & Wisler.
Hydraulic Turbines, Daugherty.
Hydro-Electric Power Stations, Rushmore & Lof.
Hydro-Electric Power, Lyndon.
Hydrology, Mead.
Nile Control, MacDonald.*
Report on Investigation of River Discharge Measurements, Egypt.*
Sewerage and Sewage Treatment, Babbitt.

* Gift.

Railroads and Highways

Car Builders Encyclopedia.
 City Pavements, Besson.
 Design of Railway Location, Williams.
 Locomotive Encyclopedia.
 Maintenance of Way Encyclopedia.
 Manual, American Railway Engineering Association.
 Motor Transportation for Merchandise and Passengers, White.
 Railroad Electrification, Manson.
 Railroad Engineering, Raymond.
 Rural Highway Pavements, Harger.*

Electrical

Electricity and Magnetism for Engineers, Pender.
 Electrical Vibration Instruments, Kennelly.*
 E M F Electrical Year Book.
 Yearbook of Wireless Telegraphy.

Mechanical

Machine Design, Leutwiler.
 Machinery Foundations and Erections, Croft.
 Mechanics of Machinery, Heck.
 Steam Power Plant Engineering, Gebhardt.

Miscellaneous

Depreciation of Public Utility Properties, Riggs.
 Design of Diagrams, Hewes & Seward.
 Estimating Building Costs, Dingman.*
 Life and Times of Alvah Crocker.*
 MacRae's Blue Book.*
 Material Handling Encyclopedia.
 Materials of Construction, Mills-Hayward.*
 Modern Tunneling, Brunton & Davis.
 Plan Reading and Quantity Surveying, Dingman.*
 Robert Fulton and the Submarine, Parsons.*
 Who's Who in Engineering.

Report of Committee on Social Activities

BOSTON, March 19, 1924.

To the Boston Society of Civil Engineers:

Your Committee on Social Activities submits the following report for the year 1923-24.

During the year we have served about 1,125 people at the eight buffet suppers, or an average of 140 people per supper. In each case the supper was

* Gift.

a substantial and we hope a satisfying meal. Those at supper have paid twenty-five cents per capita, and with this added income we have been able to close the year with a net expense to the Society slightly more than allowed us by the budget.

We have had three noteworthy evenings — the meeting in April, when we entertained the Affiliated Technical Societies of Boston, with a record-breaking attendance at supper of 265; the November meeting, when we again entertained the Affiliated Societies, with about 225 present; and the February meeting, when we were host to the civil engineering students from Harvard, Northeastern University, Technology and Tufts, with an attendance of 185. This latter meeting was the first, for some time at least, to which engineering students from so many schools were particularly invited. During the supper and from then until our President took charge we had a delightful musical program furnished by the students. The Committee hopes that there will be a meeting each year to which the students will be especially invited.

Plans for the June outing did not materialize very successfully. A number of the members were at that time planning for a trip to the Leviathan, and this, coupled with showery weather, decreased the probable attendance. Our plans had called for a trip to the new Cambridge filtration plant, followed by an outing at Norumbega Park. The outing was cancelled, although about 40 attended the inspection trip.

The program for this evening has been prepared by a committee consisting of Charles R. Berry, Frank L. Flood, Erwin Harsch, Harold W. Kelly, David C. Milne, Ernest D. Mortenson, Edwin B. Murdough, Walter A. Woods, and the Chairman, several of whom have spent a large amount of time in its preparation. We have endeavored to provide an entertainment which will be of a pleasing nature and we trust that the Society members will enjoy themselves.

The Chairman wishes to commend the energy and spirit of Frank L. Flood and David C. Milne in their work on the Committee. To them and others of the Society who have helped from time to time are due the thanks of the Society for whatever has been achieved. The other regular members on the Committee changed their residence during the year and hence resigned from the Committee. For another year it might be well to consider the advisability of enlarging the membership of the Committee so as to insure a larger number of workers at the regular meetings.

I cannot close this report without speaking of the advice and help which the Secretary of the Society, John B. Babcock, has given to the Committee. We extend many thanks to him for his co-operation.

If the Society has grown in a spirit of friendship and helpfulness among its members, the Committee will feel pleased with the year's activity.

Respectfully submitted,

KENNETH C. REYNOLDS, *Chairman.*

Progress Report of Committee on Subsoils of Boston

To the Boston Society of Civil Engineers:

BOSTON, March 19, 1924.

The Committee on Boston Subsoil wishes to report progress in its work of gathering data relating to the character of the subsoil in Boston and the immediate vicinity.

Approximately 600 boring reports have been collected from various sources and examined. These reports have been transferred to cards for reference, indexed, and located upon maps.

One of these maps, including the peninsula of Boston, has been made as a preliminary drawing, and is now on exhibition in the rooms of the Affiliated Societies. On this map is shown the outline of the original shore line of the peninsula as accurately as known, which will allow the observer at a glance to note the extent of the filling which has been necessary to permit Boston's expansion.

The location of borings is shown by prominent white circles which represent groups and seldom single borings. Each circle on the plan may thus represent one or many borings, all of which may be seen in detail by referring to the cards.

Consideration has been given the classification of soils, but it has been thought best so far to keep this in its simplest form and corresponding to that stated in the Boston Building Law.

The Committee has under way cross sections through the city which it is hoped will aid in a better understanding of the depth and distribution of the subsoils and rock floor.

Referring to the recent article in the December, 1923, JOURNAL of the Society, by Irving B. Crosby, entitled "The Earthquake Risk in Boston," we wish to say that the members assisted Mr. Crosby in securing some of the data, and heartily approved the publication of the article in the JOURNAL as being of considerable value to engineers.

Data regarding the rock floor under Boston, which either corroborate or change the contours shown on the map accompanying the article, would be greatly appreciated by the Committee.

Regarding the matter of making borings, it is found that few borings refer to surface grades, which are in turn referenced to established city grades.

This leaves many reports of doubtful value, and leads us to urge all members having borings made to insist that the people making the borings tie the surface from which the borings are made to some city grade. This may cost a little more money and take a little time but appears to be worth it.

The Committee wishes to acknowledge the hearty co-operation of the individual companies making borings and of the departments of the city in permitting and assisting us to obtain copies of borings and other data pertaining thereto.

We recommend that the work of the Committee be continued.

Respectfully submitted,

H. E. SAWTELL, *Chairman,*
for the Committee.

Report of the Executive Committee of the Sanitary Section

BOSTON, March 5, 1924.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year five meetings were held, the subjects and speakers being as follows:

March 7, 1923. — Annual meeting. "Engineering and Public Health," by M. N. Baker.

October 3, 1923. — "Some Details of Boston Sewer Work," by Edgar S. Dorr.

November 7, 1923. — An informal talk on the "Measurements of Water in Pipe Lines by Means of a Salt Velocity Method," by Prof. Charles M. Allen.

December 5, 1923. — "Behavior and Methods of Control of Quicksand and Other Soils met in Ordinary Excavation," by Col. Charles R. Gow.

February 6, 1924. — "Elimination of Odors," by Almon L. Fales.

In June, 1923, the Society joined with the Sanitary Section in an excursion to the new water filtration plant of the city of Cambridge.

Membership. — According to the records of the Secretary of the Society, the total membership of the Sanitary Section is 197, 8 new members having joined and 6 members having retired.

Special Committees. — There are now no special committees in the Section.

Attendance. — The average attendance during the past year has been 46 persons.

Respectfully submitted,

For the Executive Committee,
HARRISON P. EDDY, Jr., *Clerk.*

Report of the Executive Committee of the Designers Section

BOSTON, March 12, 1924.

To the Designers Section of the Boston Society of Civil Engineers:

During the past year seven regular meetings of the Designers Section have been held.

The regular January meeting was omitted and in its place the Section conducted the January meeting of the main Society.

The regular meetings are summarized as follows:

March 14, 1923. — Annual Meeting. Speaker, J. Stuart Crandall, Treasurer of the Crandall Engineering Company of East Boston, and a member of the Designers Section. Subject, "Elements of Floating Dock Design." Attendance 25.

April 12, 1923. — Speaker, Mr. Howard M. Turner, Consulting Engineer, of Boston. Subject, "Structural Details of Water Power Plants." Attendance 43.

May 9, 1923. — Speaker, Prof. William F. Jones, Assistant Professor of Structural Geology at Massachusetts Institute of Technology. Subject, "Engineering Aspects of Geology." Attendance 31.

October 10, 1923. Speaker, Mr. Kenneth Moller, of the firm of Lockwood, Greene & Co. Subject, "The Design of Textile Mills." Attendance 74.

November 14, 1923. Speaker, Mr. William W. Lewis, Assistant Engineer of the Boston Transit Department. Subject, "Unusual Features in the Design of New Ferry Slips for the City of Boston." Attendance 25.

December 12, 1923. — Speaker, Mr. John J. Gillespie, Head of the Industrial Engineering Division of the Department of Agencies, United Shoe Machinery Corporation. Subject, "The Design of an Ideal Shoe Factory Building." Attendance 33.

February 13, 1924. — Speaker, Mr. Frederic H. Fay, of Fay, Spofford & Thorndike, Consulting Engineers, Boston. Subject, "The Design of Terminals and Warehousing Facilities." Attendance 60.

The executive committee held three meetings during the year, March 29, 1923, September 13, 1923, and February 15, 1924.

Twenty new names have been added to the Section and 3 dropped, making a gain of 17 for the year. The total membership now stands at 90.

The average attendance at the meetings was 41, a gain of 15 over the year before.

The attendance at the meetings of the Section has shown a healthy increase during the year just closed, and we believe this is due, in part at least, to the sending of invitations to various offices in the city where there are several men who are or should be interested in our meetings. Even if we could trace no increase in attendance directly to this, we believe that this publicity given the Society is well worth the continuance of the custom, and recommend that it be continued.

We also recommend that some committee work be developed in the Section and the Society; and the Section as now constructed has the ability and the willingness to make committee investigations and reports which would be a credit to the Society.

It is further suggested that the establishment of an annual prize for a paper from a member of the Section on some matter of design, theory or practice in which the writer had a responsible share would be of great benefit. This would not need to be of great intrinsic value, a certificate and suitable notation in the year book, as is done by the A. S. C. E., would serve the purpose.

Respectfully submitted,

For the Executive Committee,
WALDO F. PIKE, Clerk.

MINUTES OF MEETINGS

BOSTON SOCIETY OF CIVIL ENGINEERS

BOSTON, March 19, 1924. — The seventy-sixth annual meeting of the Boston Society of Civil Engineers was called to order at 5.20 P.M. at the Boston City Club by the President, Frank M. Gunby.

The minutes of the previous meeting were approved as printed in the March JOURNAL.

The Secretary reported for the Board of Government the names of those elected to membership:

Members: Nathan Whitman Littlefield, Jr., Francis John Mulvihill, Walter H. Smart, Frank H. Stuart.

Juniors: Willard Haven Johnson, Charles Weller.

The President announced that an Affiliation meeting would be held in the latter part of April. In accordance with the recommendation of the Board of Government the Society voted to omit the regular meeting of April 16 in order to increase the interest and attendance at the Affiliation meeting.

The Secretary reported for the Tellers the result of the letter ballot on the question "Shall the Boston Society of Civil Engineers withdraw from membership in the Federated American Engineering Societies?" Affirmative, 328; negative, 101.

The annual reports were then taken up. The reports of the Board of Government, Treasurer, Secretary, Committee on Social Activities, Committee on Library, and the Committee on Sub-Soils of Boston were presented.

It was voted that these reports be accepted and placed on file. The President announced that these would be published in the April JOURNAL.

It was voted that the incoming Board of Government be authorized to appoint such committees as it deemed desirable.

The Secretary presented for the Tellers their report on the

election of officers, and in accordance therewith announced that the following officers had been elected:

President — Edwin H. Rogers.

Vice-President (for two years) — Frank A. Marston.

Secretary — John B. Babcock.

Treasurer — Frank O. Whitney.

Directors (for two years) — Charles R. Main, Frank E. Winsor.

Members of Nominating Committee (for two years) —
David A. Ambrose, Charles R. Berry, Frank A. McInnes.

Mr. Edwin H. Rogers, the newly elected President, was introduced and spoke briefly. Mr. Frank A. Marston, the new Vice-President, was next introduced and responded with a few brief remarks.

The President then introduced Mr. Desmond FitzGerald, an honorary member of the Society, who presented to Mr. Arthur T. Safford the Desmond FitzGerald medal for his paper on "The Amoskeag Manufacturing Company's Hydro-Electric Development," published in the March, 1923, JOURNAL.

The President announced that the Board of Government had awarded copies of Clemens Herschel's "Frontinus and the Water Supply of Rome" to Mr. John W. Raymond, Jr., for his paper on "Some Features of Sewer Design," published in the January, 1923, JOURNAL, and to Mr. J. Stuart Crandall for his paper on "Floating Dry Docks," published in the September, 1923, JOURNAL. The President then presented these books to Messrs. Raymond and Crandall, and called particular attention to the fact that both these papers had been presented before the Designers Section, of which they were members.

The retiring president, Mr. Frank M. Gunby, then delivered his annual address, on "The Indictment and Suits Against the Cantonment Constructors."

The business meeting thereupon adjourned and the members attended the supper and entertainment provided by the Committee on Social Activities. After the supper a radio stunt was introduced. There was so much divergence of opinion as

to which features of this were *bona fide* and which were "fake" that the Committee in charge has decided not to enlighten the members on this point.

Following the radio demonstration Mr. K. C. Reynolds, Chairman of the Social Activities Committee, presented Mr. Carveth Wells, Engineer-Explorer, who greatly entertained for the rest of the evening with a lecture on the "Humorous Side of Railroading in a Jungle," illustrated by colored slides and moving pictures.

Mr. Wells told of his amusing experiences in a six-years' sojourn on the Malay peninsula locating a railroad for the British government.

After the meeting adjourned a number of the members inspected the radio apparatus which had been so kindly loaned by the Federal Telephone and Telegraph Company of this city.

There were 236 members and guests present at the supper in addition to a few who attended the business meeting but were unable to remain for the supper.

Adjourned at 9.40 P.M.

J. B. BABCOCK, *Secretary*.

SANITARY SECTION

BOSTON, March 5, 1924. — The annual meeting of the Sanitary Section of the Boston Society of Civil Engineers was called to order at 7.45 P.M. in the library of the Society by the Chairman, John P. Wentworth.

The minutes of the previous meeting were read and approved.

The annual report of the Executive Committee was read and approved.

Mr. Wright, Chairman of the Nominating Committee, presented the following nominations for officers for the ensuing year:

Chairman — Gordon M. Fair.

Vice-Chairman — G. Gale Dixon.

Clerk — H. P. Eddy, Jr.

Executive Committee — H. B. Allen, E. S. Chase,
R. W. Horne.

It was unanimously voted that the Clerk cast one ballot for the nominees named.

Then followed a long discussion on the advisability of changing the time of the meeting from 7.45 P.M. to an earlier hour. Several suggestions were made, including 6, 7, 7.15 and 7.45 P.M., and informal votes were taken on each hour, but in each case the majority of the members present were opposed to the hour suggested.

Mr. Stephen DeM. Gage moved, and it was seconded and passed, that the notice of the next meeting include a statement that there would be discussion of the matter at that time, and a request for written discussion by members unable to be present.

Following the business meeting, Mr. Stephen DeM. Gage, Sanitary Engineer, Rhode Island Board of Purification of Waters, read a paper on "The Control of Pollution by Oil of Public Waters in Rhode Island."

Following the paper there was a discussion by Messrs. A. L. Fales, Edward Wright, R. S. Weston, A. L. Gammage, G. M. Fair, and others.

Attendance was about 40.

Meeting adjourned at 10.30 P.M.

HARRISON P. EDDY, Jr., *Clerk.*

DESIGNERS SECTION

BOSTON, March 12, 1924. — The annual meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6.20 P.M. by the Chairman, Walter W. Clifford.

The report of the February meeting was read and accepted. The annual report of the Executive Committee was read. It was moved that the report be accepted and transmitted to the Secretary of the main Society. Motion carried.

The report of the Nominating Committee was read and accepted. It was moved that the Clerk cast one ballot electing

the officers nominated. Motion unanimously carried. The Clerk cast one ballot, electing the following officers:

Chairman — Edward H. Cameron.

Vice-Chairman — Hale Sutherland.

Clerk — Waldo F. Pike.

Executive Committee — Erwin Harsch, Scott Keith,
Harold F. Marnell.

The Chairman introduced Mr. M. H. Hallenbeck, Consulting Engineer, of Boston, who spoke upon "The Design of Paper Mills." Mr. Hallenbeck said that there was no standard design for paper mills. He brought out the necessity for a location near a large supply of clean water and a railroad connection. He described the process of manufacture and the machinery.

A discussion followed the talk.

Mr. Walter W. Clifford, the retiring chairman, thanked the members and officers for their co-operation during the past year and introduced the new chairman, Mr. Edward H. Cameron.

Mr. Cameron introduced the new officers.

There were 27 members and visitors present.

The meeting adjourned at 7.20 P.M.

WALDO F. PIKE, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[April 15, 1924.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

DELANEY, J. FRANK, Dorchester, Mass. (Age 27, b. Boston, Mass.) Graduate of Tufts College in 1920. Experience: three and a half years as resident engineer on construction work for C. H. Tenney & Co. Refers to Robinson Abbott, A. J. Harty, E. H. Rockwell, F. C. Sargent.

HARRIMAN, HENRY I., Newton, Mass. (Age 50, b. Brooklyn, N. Y.) President of the New England Power Company and Chairman of the Metropolitan Planning Board. Refers to G. W. Cutting, F. H. Fay, R. K. Hale, D. C. Jackson, W. P. Morse, E. H. Rogers.

HUTCHINS, EVERETT NELSON, Malden, Mass. (Age 39, b. Dover, N. H.) Graduate of Harvard College, 1908, and Lawrence Scientific School, 1909, with degree S.B. in civil engineering. From 1909-10, instrumentman with Charles River Basin Commission; 1910-11, assistant engineer, Board of Water Supply, New York City; 1911-13, inspector, Board of Water Supply, New York City, on tunnel construction; 1913-15, designing draftsman, Directors of the Port of Boston; 1915 to date, with the Commission of Waterways and

Public Lands and now with Division of Waterways as designing engineer. Refers to J. N. Ferguson, R. K. Hale, H. J. Hughes, L. J. Johnson, J. P. Wentworth, W. F. Williams.

MITSCH, J. DONALD, Mattapan, Mass. (Age 26, b. Boston, Mass.) Graduate of Massachusetts Institute of Technology in 1920. For two years assistant instructor at M. I. T., one year as estimator of building construction in New York City, and at present instructor in civil engineering at M. I. T. Refers to J. B. Babcock, J. W. Howard, K. C. Reynolds, C. M. Spofford.

QUINN, FRANCIS B., Medford Mass. (Age 21, b. Medford, Mass.) Educated in the public schools of Medford. During summers of 1920 and 1921 was rodman and transitman with the city of Medford; lot surveyor during college spare time in 1921-22; from August to January, 1922, and April to September, 1923, assistant engineer, Grade B, on construction work for the Department of Public Works, Division of Highways. At present a student at Tufts College. Refers to Robinson Abbott, A. W. Dean, J. J. Horgan, E. R. McCarthy, C. S. Toole.

THOMPSON, WALTER L., Cambridge, Mass. (Age 23, b. Remsen, N. Y.) From December, 1918, to August, 1920, draftsman in power and plant division of the Yale & Towne Manufacturing Company, Stamford, Conn.; from September, 1920, to June, 1922, a student at Massachusetts Institute of Technology; from September, 1922, to June, 1923, a student at Wentworth Institute, in department of architectural construction; through the summer of 1923, draftsman on mechanical equipment in a chemical plant; from August to October, 1923, draftsman on frame construction; from October, 1923, to the present, a student at Wentworth Institute. Refers to J. B. Babcock, E. A. Varney.

WALDMAN, JULIUS, Chelsea, Mass. (Age 21, b. Chelsea, Mass.) Junior at Tufts College. During summers of 1919 to 1922, he was draftsman and foreman for L. Waldman & Sons, Contractors and Builders. Assistant Engineer, Grade B, on construction for Department of Public Works, Division of Highways, September, 1923, to February, 1924. Refers to Robinson Abbott, A. W. Dean, W. H. Johnson, E. R. McCarthy, J. A. O'Brien, E. H. Rockwell.

For Transfer from Grade of Junior

GINDER, CHESTER JAMES, Everett, Mass. (Age 26, b. Natick, Mass.) Graduate of Northeastern University. During work periods employed by Whidden-Beekman Construction Company, also by Aspinwall & Lincoln. Work covered all kinds of city and country surveys, land development, street layout; also was drafting with Stone & Webster, Inc., September, 1920, to January, 1921; now an instructor in civil engineering at Northeastern University and assistant registrar of the School of Engineering. Refers to H. B. Alvord, C. S. Ell, F. L. Flood, J. W. Ingalls, W. E. Nightingale.

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DEATH

ROWE, RANSOM J.....	April 1, 1924
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LIBRARY NOTES

BOOK REVIEW

"RURAL HIGHWAY PAVEMENTS—MAINTENANCE AND RECONSTRUCTION," by Wilson G. Harger, C.E., Engineer, New York State Department of Highways; former Service Engineer, Highway Engineer, U. S. Office of Roads; Author, "Highway Engineers Handbook." First Edition. McGraw-Hill Book Company, New York. 637 pp.

REVIEWED BY CHARLES B. BREED *

"Rural Highway Pavements," by Wilson G. Harger, is a new book on highway construction, exclusive of city streets. The text of 500 pages is divided into five chapters, on Administrative Considerations, Principles of Pavement Design, Details of Design and Construction, Maintenance and Reconstruction, and Design of Road Accessories. The text is followed by an excellent Appendix on Materials and Tests.

To many readers the book will appear to be poorly arranged for ready reference. The running titles at the tops of the pages are of no assistance in this respect and the index is incomplete and lacks specific characteristics. To logically arrange a book on highways is no mean task. The personal equation of readers is not alike, and it would be an impossibility to arrange a book on so broad a subject to the satisfaction of all.

In writing on this subject one of the main difficulties is to decide upon what shall be omitted. In this respect the author has wisely omitted all ancient history and confined his text to modern construction. He makes frequent use of dates when quoting prices.

As a text the book is by no means suitable for the beginner. It can hardly be classed as a satisfactory text; the principles of road building are too much confused with practice and construction hints to meet text requirements. It is by no means a

* Professor of Railway and Highway Engineering, Massachusetts Institute of Technology, Cambridge; Consulting Engineer, 6 Beacon Street, Boston, Mass.

layman's book; it is for the practicing highway engineer. It is an up-to-date reference book of distinct professional value.

In spots, like all books, it is weak. This is especially noticeable in the lack of different well-established Portland cement concrete pavement construction methods. It has almost no references to the best of the published articles on the different subjects treated, which, if included, would have added considerably to the value of this volume.

Some of the illustrations could to advantage have been omitted because they have little or no educational value, and their introduction for the purposes of developing the interest of the reader can hardly be sufficient reason for their incorporation in a book of this character.

Considerable of the text is quoted specifications and reports, and might upon first reading give the engineer the impression that it is largely a compilation of already published facts. To a considerable extent this is true; there is little in the book that has not already been published in some form or other. But the task of selecting from the vast amount of valuable and useless, of novel and redundant mass of published reports, brochures and texts and selecting therefrom the "wheat" has been well done.

RECENT ADDITIONS TO THE LIBRARY

U. S. Government Reports

Water Supply Papers, No. 497.

Municipal Reports

Belmont, Mass. Annual Report of Water Commissioners. 1923.

Burlington, Vt. Annual Report of Water Department. 1923.

Danvers, Mass. Annual Report of Water Commissioners. 1923.

Dover, N. H. Annual Report of Board of Water Commissioners. 1923.

Laconia, N. H. Annual Report of Board of Public Works. 1923.

Providence, R. I. Annual Report of Department of Public Works. 1923.

Reading, Mass. Annual Report of Board of Public Works. 1923.

Rutland, Vt. Annual Report of City of Rutland. 1923.

Miscellaneous

Alternating Current Motors. McAllister.

American Hydro-electric Practice. Taylor & Braymer.

Design of Concrete Structures. Urquhart & O'Rourke.

Design of Railway Location. Williams.

Earth Pressure, Retaining Walls and Bins. Cain.

Economics of Electrical Distribution. Reynau & Seelye.

Electric Power Transmission. Still.

Electric Railway Handbook. Richey.

Engineering of Power Plants. Fernald & Orrok.

Geodesy. Hosmer. Gift of Author.

Highway Engineers' Handbook. Hubbard.

History and Progress of Metallurgical Science. Hadfield.

Hydraulics. King & Wisler.

Materials of Construction. Edited by H. W. Hayward.

Gift of Author.

Mechanical Drawing for High Schools. French & Svensen.

Mines Branch Investigations. Department of Mines. Canada.

Mining Engineers' Handbook. Peele.

Modern Tunneling. Brunton & Davis.

Mosquito Eradication. Hardenburg.

Practical Electricity. Croft.

Principles of Direct Current Machines. Langsdorf.

Railroad Engineering. Raymond.

Railway Estimates. Lavis.

Railway Signaling. King.

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Work and Position of the Metallurgical Chemist. Hadfield.

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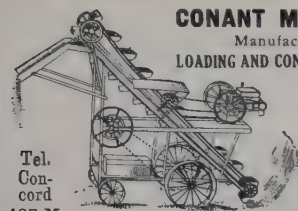
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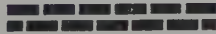
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